THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION'S

GODDARD SPACE FLIGHT CENTER

APPLICATION FOR THE

PRESIDENT'S QUALITY AWARD PROGRAM

1997

TO INVENT AND PERFECT
UNIQUE TOOLS OF DISCOVERY,
TO EXPLORE EARTH AND UNIVERSE,
WITH PARTNERS AROUND THE WORLD,
TO MAKE A BETTER WORLD.

Since its founding in 1959, the Goddard Space Flight Center has had a tradition of excellence in science and technology. Goddard is America's largest science research laboratory and a world leader in the development of unmanned scientific satellites. Our science and technology products have revolutionized mankind's understanding of the Earth and the universe and advanced the state of American technology. We are committed to enhancing our processes and improving our efficiency to continue our record of product excellence into the twenty-first century.

1. Organization Description

The Goddard Space Flight Center is NASA's Center of Excellence for scientific research. We are an integral part of the NASA agency team. In its Strategic Plan, NASA has assigned us key leadership responsibilities within three of the five Agency Strategic Enterprises through which NASA implements its overall mission (see figure 1). To carry out our vital role within NASA, Goddard will:

- enable discovery through leadership in Earth and space science;
- partner with others to achieve NASA's goals;
- serve the scientific community, inspire the nation, foster education, and stimulate economic growth;
- create technologies that support and advance these endeavors to take full advantage of doing research in space; and
- accomplish this through innovation in all we do.

Figure 1 illustrates Goddard's product development cycle, identifying both our processes and the products that they yield. Table 1 lists a few of the major scientific discoveries and technology advances that our products have enabled. We take pride in our product excellence, in our contributions to technological advances and scientific discoveries, and in how our work has benefited the people of the world.

NASA Goddard Space Flight Center

Our People
3,500 Civil Servants 9,000 Contractors

Our Places

	Greenbelt, MD	Wallops, VA	New York NY
Employees	11,400	1,050	50
Buildings	50	84	1

Our Products
- 172 satellites launched into orbit
- 86 Space Shuttle Missions supported
- 2,500 Suborbital Rockets launched
- Innumerable Science Technology and Educational Advancements enabled

Our Programs
- NASA's Center of Excellence for Scientific Research
- Primary Center Responsibility for three of five Agency Strategic Enterprises:

NASA Enterprises	Goddard Role
• Mission to Planet Earth	• Lead Center
• Space Science	• Astronomy & Space Physics
• Space Technology	• Lower Orbit Spacecraft Technology Development

- Partnerships with Multiple US & Foreign Space Organizations
- $2.7B Budget in FY 96

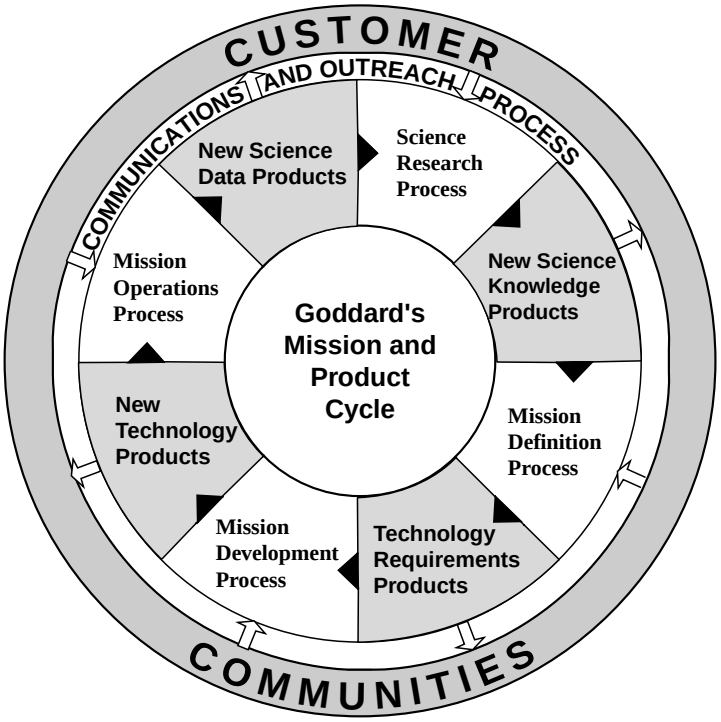


Figure 1. The Goddard Mission and Product Cycle

Table 1.

Goddard-Enabled Science & Technology Discoveries & Advances		
Earth Science Advances	Space Science Discoveries	Technology Advances
Mapping of the Antarctic Ozone Hole	Earth's Radiation Belts	Weather Satellites
Understanding of the El Niño Mechanism	Oldest structure in the universe	Communication Satellites
Quantifications of the Greenhouse Effect	Concentrations of dark matter in galaxies	On-orbit satellite maintenance & repair
Mapping of Global Ocean Circulation	X-ray emissions from comets	Space-based remote sensing
Measurement of Rain Forest Destruction	Magnetic fields of other planets	Radiation resistant microprocessors

Goddard's two key products are **new science** and **new technology** (see Table 2 for a listing of our other products.) Our past successes have been characterized by the excellence of these products. Our future successes depend upon a continuation of that excellence.

Goddard's best known **new technology products** are Earth-orbiting spacecraft carrying scientific instruments that continually monitor Earth's lands, seas, and atmosphere, and peer out to the edge of the universe from the unique vantage point of outer space. We also use suborbital rockets and balloons for low-cost, fast-delivery science missions. We build sophisticated computer models, and state-of-the-art science data archive and distribution systems. We also build, operate, maintain, and continually enhance a world-wide complex of communication and control systems that support NASA's orbiting spacecraft, NASA's Space Shuttle, the future Space Station Freedom, and several Department of Defense (DoD) programs.

Goddard's **science products** include both the **new science data** that is created through our technology products, and the **new science knowledge** that stems from use of that data. We operate our satellites, instruments, and supporting systems to make observations of distant stars and galaxies to better understand the development and workings of the universe. We use them to explore the Earth, to learn more about the natural processes that impact our weather and climate, and to learn how human activities impact the environment. We archive the new science data from these measurements and observations, and distribute that data to our own scientists, and to thousands of scientists and educators around the world, enabling them to create new science knowledge. We disseminate this knowledge through our education and outreach programs to the American people.

Our products offer unique capabilities. A satellite, for example, can track a hurricane precisely by pinpointing its exact location once every fifteen minutes, or quickly measure the extent of flooding of major rivers, the damage caused by volcanic eruption, or the size and location of oil spills and similar disasters.

Goddard technology products are built to meet the needs of our key customers, Earth and space scientists. At the start of each new mission, scientists define new science objectives for that mission, and work closely with Goddard-led teams to define and build the new technology products that will achieve those objectives. We measure the success of our technology products against those science objectives.

Figure 1 shows Goddard's size and location. Our 3,500 civil servants include:

Discipline	Education/Degrees
59% Scientist/Engineer	12% - Ph. D.
21% Professional/Admin	18% - Masters
10% Clerical	41% - Bachelors
8% Technician	4% - Associate
2% Wage Grade	25% - Non-Degree

-3 Bargaining Units - 1,996 people

Goddard is managed by a system of functionally aligned **directorates**, responsible for Goddard's processes. Directorates share responsibilities in our cross-functional processes. Figure 2 lists our directorates and their numeric designators, and indicates the roles they play in Goddard's science and technology products. The Suborbital Projects and Operations Directorate operates from our Wallops, VA facility. The Goddard Institute for Space Studies, our New York facility, is part of the Earth Sciences Directorate.

To accomplish specific science missions, or develop specific products, directorates cooperate to establish and maintain cross-functional **mission teams**. These teams are process oriented, and change in nature and composition as the mission evolves through its cycle. They include

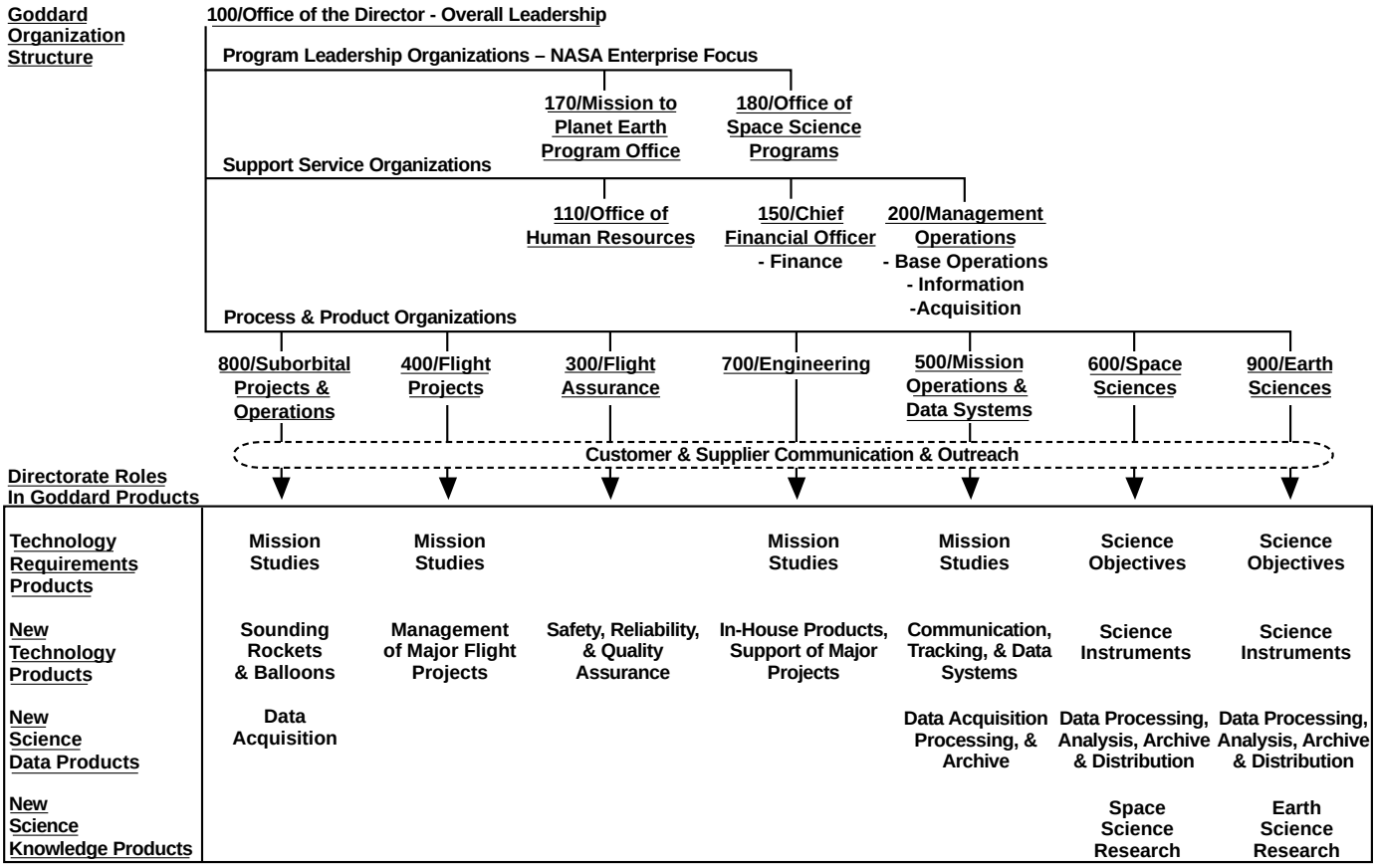


Figure 2. The Goddard Organization

members from customer and supplier communities. Key personnel serve as team members through all phases of the complete mission cycle, providing continuity, constant focus on science customer's objectives, and continuous customer orientation. Whether they are called Projects, Working Groups, or given some other name, Goddard mission teams all have specific and detailed **mission objectives** to accomplish, **products** to develop, **technical requirements** to satisfy, and **schedules and budgets** to meet.

Goddard manages and operates advanced and sophisticated facilities for the design, fabrication, test, and operation of space systems, and for processing, archiving, and distributing science data. These include comprehensive environmental test facilities which simulate the harsh environment of space, special clean rooms used to process contamination-sensitive spaceflight hardware such as optical telescopes, and major science data processing and archive facilities. Support facilities include specialized research and development laboratories that complement the capabilities of our industry partners.

Goddard has employed many of the fundamental practices of Quality Management since its founding. Goddard established a Quality and Productivity Office in 1984, introduced a Total Quality Management (TQM) program in 1990, and converted that to a Continuous Improvement (CI) program in 1994. Goddard initiated the annual Contractor Award for Quality and Productivity in 1988. The Director and the Quality and Productivity Officer created a Quality Working Group in 1989 which prepares an annual Goddard initiatives report and an Agency Initiatives Report Card. In 1990, the Director chartered a senior TQM Review Team to examine TQM applicability, resulting in the Deputy Director being charged with overall responsibility for quality at the Center. In 1991, the Director created the Goddard Contractor Association (GCA), chartered to improve the teaming between Goddard and key suppliers. In 1992, Goddard contracted with the firm of Organizational Dynamics, Inc. to train Center leadership.

2. Customer Requirements

Goddard's principal customers include:

- Scientists
- NASA Headquarters
- other Government Organizations
- Commercial Organizations
- the General Public

Our customer communities and their quality requirements for our products are shown in Table 2. All our customers are voluntary customers—if our products don't provide value to them, they are free to go to other government and commercial space organizations. Our **scientist** and **NASA Headquarters** customers are especially key to our mission. Our **scientist** customers, who are competitively selected by their peers in the international science community, establish the science objectives for our missions, participate as key members of our mission teams through completion of the mission cycle, and use the new science data and new science knowledge products of our missions in their individual research activities. In the mission definition process, mission scientists and Goddard mission teams work closely with **NASA Headquarters** to turn science objectives into clear sets of new mission requirements. NASA Headquarters then enables our missions, asking for and obtaining funding from Congress and the White House, and playing a key role in mission teams throughout the entire mission cycle.

For our **government** customers, quality requirements are specific for each mission. Our partnerships with foreign space agencies are primarily for scientific missions, making their requirements similar to those of our scientist customers. Our partnerships with the National Oceanic and Atmospheric Administration (NOAA), other NASA centers, and the DoD often involve operational systems with specialized, mission-unique quality requirements.

Our **commercial** customers are less direct users - they incorporate our products and technology into their own product development, to market commercially or to other governments. The **general public** is also a user, benefiting from the practical results of science research, such as the severe storm warnings and environmental monitoring made possible by our products. The American people share the wonder of our scientific discoveries, benefit from the application of space technology to every-day problem solving, and share our pride in mission success. Students at colleges, high schools, and grade schools across the country are offered the increased knowledge of the Earth and the universe that results from our products. These students represent NASA's and America's future. Our ambition is to inspire them, and help prepare them to meet America's challenges by ensuring our nation's competitiveness in the world.

Table 2. Matrix of Goddard Products and Customer Quality Requirements

Customers & Their Communities	New Science Knowledge Products	New Science Data Products	New Technology Products	Technology Requirements Products
Scientist – World Earth & Space Science Community	–Relevant –Timely –Peer Reviewed –Accessible	–Accessible –Error Free –Calibrated –Documented	–Capability to meet mission science objectives with manageable risk	–Relevant –Competitive –Feasible
NASA HQ – NASA Enterprises	–Relevant –Timely –Peer Reviewed	–Accessible –Error Free –Calibrated –Documented	–Capability to meet mission science objectives with manageable risk	–Relevant –Competitive –Feasible
Government – U.S. & Foreign Agencies	–Relevant –Timely	–Accessible –Error Free –Calibrated	–On schedule –Compliance with Agreements	–Relevant –Feasible
Commercial – U.S. Commerce/ Industry	–Commercially relevant	–Commercially relevant	–Commercially relevant	–Feasible, non-restrictive
General Public – American People	–Relevant –World Class –Inspirational	–Relevant –World Class –Educational	–Relevant –World Class –Useful	–Relevant –World Class –Practical

3. Supplier Relationships

Goddard's **principal suppliers** play an essential role in our mission success. In FY 95, Goddard used 90% of its budget for contracts and grants, awarding 297 new contracts, obligating $2.2B dollars. $238M of this went to Small/Small Disadvantaged businesses and $220M to universities and nonprofit research organizations. Goddard has over 600 active contractors and grantees. The 25 key suppliers that belong to the Goddard Contractor Association account for 80% of contract expenditures. The following list shows our largest commercial and nonprofit suppliers.

Commercial	Nonprofit
Lockheed Martin	Association of Universities for Research in Astronomy
AlliedSignal	Univ. of Arizona
McDonnell Douglas	New Mexico State
Computer Sciences	Univ. of California – Berkeley
Santa Barbara Research	Cal Tech
Hughes Information	Johns Hopkins
Space Systems Loral	Universities Space Research
Hughes STX	Univ. of Maryland
TRW Inc.	Univ. of Alaska

4. Other Factors Important to Goddard

Goddard's principal success factor is to enable discovery in Earth and space science through technology. The Administration's efforts to reduce government and balance the budget present major challenges and exciting opportunities to attain new levels of excellence. In response, our Center Director Mr. Joe Rothenberg has accepted those challenges, and established these thrusts in our 1996 Strategic Plan:

- Allocate all resources in alignment with Goddard and NASA strategic initiatives;
- Foster and reward innovative thinking that improves processes;
- Enable more science by reinvesting savings in new initiatives;
- Reduce cost and schedule by process redesign;
- Refocus the civil service workforce via retraining and career-change opportunities;
- Strategically partner with industry, academia, and other government;
- Establish coordinated education initiatives to share science and technology benefits; and
- Evaluate progress on a regular basis.

We will move from our current way of doing business to meet these goals in our new Strategic Plan, now underway (discussed more in section 3).

The National Aeronautics and Space Act of 1958 is a key law that provides Goddard's fundamental charter to plan, direct, and conduct space activities, specifically providing for participation by the scientific community in planning and carrying out investigations through the use of aeronautical and space vehicles, and in so doing, providing for the widest practicable and appropriate dissemination of information about NASA activities. It establishes our responsibility to facilitate the commercial use of space and to use commercially-provided space services and hardware. The Act provides broad authority for NASA to develop partnerships, whether by traditional contracts, grants and cooperative agreements or by other innovative arrangements with public and private agencies, organizations and persons, in implementing NASA programs and assisting other organizations in accomplishing their missions.

Goddard has key long-term partnerships with many other government organizations, foreign and domestic. Continuation and expansion of these partnerships is a key element of our 1996 Strategic Plan. Among our key partnerships are those with:

- NOAA for their weather satellite program;
- other NASA Centers for the Shuttle and Space Station Programs;
- NASA Johnson Space Center and Jet Propulsion Labs for combined space operations; and
- the European, Russian, and Japanese space agencies for several long-term satellite programs including Hubble Space Telescope, Mission to Planet Earth,Total Ozone Mapping, and International Solar and Terrestrial Physics.

In recent years, Goddard's way of doing business has changed. Thanks to the refocusing of quality efforts by our new Center Director, Goddard is on the path to a more structured approach to quality management and process improvement. It is our objective in this application to perform a realistic assessment of where we were, where we are, and where we are going. We shall use the feedback we receive as an integral part of that process.

Goddard leadership provides the strategic direction and tools to lead our people and our teams toward achieving the Center's goals through a total commitment to quality.

1.1 Senior Executive Leadership

The vision of Goddard states that "*We revolutionize knowledge of the Earth and the universe through scientific discovery from space to enhance life on Earth.*" The Senior Executive Leadership of Goddard comprised of Center Director Mr. Joe Rothenberg, Deputy Director Mr. Al Diaz, Associate Directors Ms. Mary Kicza and Dr. Robert Price, and the Goddard Executive Council, are personally demonstrating their commitment to achieving this vision by establishing a broad range of performance goals for the Center instilled with quality values and a customer focus orientation. The Goddard Executive Council, consisting of all of the "Directors of" for each of the directorates on the Center and the "Heads" of the staff offices which report directly to the Center Director, are the direct interface to the workforce, suppliers, and customers.

1.1a(1) Creating and reinforcing values and expectations throughout Goddard's leadership system

When Mr. Rothenberg became Center Director in July 1995, he inherited an organization with an excellent reputation for technical accomplishment. Retaining the current leadership team, he reinforced the concepts of process excellence and customer satisfaction and further empowered the team to maintain Goddard's history of technical excellence and scientific leadership.

When NASA concluded its Zero Based Review earlier in the year, (an internal review conducted in response to the Administration's call for a balanced budget), it determined that NASA would have to change the way it does business. Goddard's role in that change entailed the following responsibilities: programmatic leadership of the Mission to Planet Earth Enterprise; scientific leadership in Space-based Physics and Astronomy; and Technology Research and Development to enable Earth and space science.

Upon assuming Directorship of the Center, Mr. Rothenberg accepted the challenge to develop a strategy for carrying out Goddard's responsibilities. Mr. Rothenberg first met with representatives of Goddard's key customers (as defined in the Overview) and stakeholders, including the NASA Deputy Administrator, Associate Administrators, Enterprise leaders, the Jet Propulsion Laboratory (JPL) Director and senior management, and industry leaders. From these meetings, Mr. Rothenberg *synthesized an external view of Goddard*, how Goddard is perceived by its customers. Using this external viewpoint and the identified future NASA environment, Mr. Rothenberg developed a *case for change*, the reasons and the motivation for changing Goddard, and established near-term initiatives to jump-start the process of changing the culture and value system at Goddard.

Following a series of high-level retreats with the Senior Executive Leadership of the Center, the Center Director and the Center's leadership team conducted "All Hands Meetings," followed by question and answer sessions, where they presented the *case for change*, their vision for Goddard, and the near-term initiatives Goddard must implement. These are delineated in section 1.2a.

The Center's Senior Executive Leadership has moved out aggressively to both implement these initiatives and to keep the Center's workforce informed and involved. Individuals from within the Center's leadership system and organization have been identified and, where appropriate, teams have been formed from a cross-section of the Center's workforce, to implement solutions for these initiatives. The progress of the implementation of each is detailed in section 1.2a.

Previous Center Directors established strong communications links with our customers and stakeholders. Improving these links is a major goal of the Center. It is an area where the Goddard Senior Executive Leadership has taken an active and visible role. The Center Director meets several times monthly with Congressional staff members and the local Congressional Representative, and with U.S. Senators. In addition to meetings which occur between Goddard scientists and engineers and the general science community and industry, the Director, his Deputy, and Associate Center Directors have begun meeting with nationally recognized science advisory committees. The leadership team has established quarterly meetings with the senior executives of the Center's key suppliers.

The Center Director conducts monthly meetings with NASA Headquarters Associate Administrators, Deputy Associate Administrators, Chief Scientists, and other Center Directors. The Deputy Center Director meets quarterly

with officials from the National Oceanic and Atmospheric Administration (NOAA). The entire leadership team conducts semiannual meetings with their counterparts at the JPL, Langley Research Center, Marshall Space Flight Center, Johnson Space Center, and Ames Research Center.

Associate Directors Ms. Mary Kicza and Dr. Robert Price have developed and are implementing two new ideas for improving communications with one of our customers, the Enterprises at NASA Headquarters. These are "AA Days" and "Care Abouts."

"AA Days" are a series of All Hands Meetings whereby the Associate Administrators (AAs) for the various Enterprises at NASA Headquarters are invited to come out and speak with the Goddard workforce. Three "AA Days" have been conducted so far, allowing five different AAs to speak and interact with the Goddard workforce.

"Care Abouts" are a list of items that the Center believes NASA Headquarters is concerned about and which is being used to improve the dialogue between the senior executives at the Center and NASA Headquarters. Goddard Senior Executive Leadership presents this list to their counterparts at NASA Headquarters and the discussion follows the format of the following questions: Is our focus correct? How are we doing? What are your needs? Each successive "Care Abouts" session provides a progress report related to the previous session.

The leadership team uses the many award ceremonies held at the Center to reinforce the Center's values and expectations and to recognize and honor individuals and groups whose performance has contributed to meeting the Center's goals. In addition to the Senior Executive Leadership conducting the recognition ceremonies, the Center's customers often present the awards to the workforce to reinforce the reason for which the awards are primarily given—high customer satisfaction. Details of the Center's award ceremonies are in section 4.

1.1a(2) Setting directions and performance excellence goals through strategic and business planning

Strategic planning has been used at Goddard since 1986 to set performance excellence goals for the Center. The 1991 Strategic Plan established a number of specific goals for the Center. The Center's accomplishments resulting from that plan were documented in 1994 and are shown in Table 3.2. The 1996 Strategic Plan was developed by a centerwide team led by Dr. Dorothy Zukor, Deputy Director of the Earth Sciences Directorate. Using the Center's Vision, Mission, and Values as a foundation, the team developed a plan that, while maintaining flexibility, provided Goddard with the framework to reengineer the Center's processes and organization, and establish new performance excellence goals. These new performance goals were based upon the results of the "GSFC 2005" initiative. Developed by a team comprised of a cross-section of the Goddard leadership and led by Deputy Center Director Mr. Al Diaz, "GSFC 2005" built upon the Center's vision statement, and set business performance goals for Goddard through 2005, with the primary objective of accomplishing *more science for less through technology and new ways of doing business.* "GSFC 2005" established four goals for the Center to pursue into the next century: reducing mission costs, reducing mission development times, increasing flight rate of missions, and increasing use of commercial products and services.

Each of these four goals is a direct reflection of the Center's customer focus. Metrics were identified for each of the goals, as well as opportunities to demonstrate progress toward these goals in both the short- and long-term time frames. A more detailed discussion of the Center's strategic planning process is in section 3.

1.1a(3) Reviewing overall Goddard performance, including customer-related and operational performance

The Center's Senior Executive Leadership is personally and visibly involved in reviewing and improving the total performance of the Center on a regular basis. Goddard has in place a number of well established systematic reviews (section 1.2b) chaired by members of the Center's leadership team which form an integrated system for the leadership team to assess the Center's performance. These reviews provide regular and frequent opportunities for the leadership team to ensure work-unit and centerwide consistency with Goddard's goals and expectations and to apply corrective action when necessary. At each successive review, the leadership team assesses the progress made toward the Center's goals and makes a determination as to the need for further action. They use the following procedures to review performance:

- The Senior Executive Leadership instituted a weekly "Top Ten" list in which every directorate provides a list of their top ten issues and the actions being taken to resolve the problems. These lists are

developed from similar lists generated by the work-units and projects within the directorates.

- The Center Director chairs the weekly Executive Council meeting in which members of the leadership team review the weekly "Top Ten" and other issues affecting the Center, its suppliers, and its customers.
- Chaired by the Deputy Center Director, the entire leadership team attends quarterly status reviews of the Center's major programs, projects, and divisions.
- The "Directors of", in conjunction with the Associate Directors for the Space Sciences and Mission to Planet Earth Program Offices, chair monthly status reviews of their projects, divisions, and work-units.

The Senior Executive Leadership takes an active role in evaluating the performance of Goddard's suppliers and team members. Members of the leadership team assist Project Managers in setting contractor performance goals, through written Award Fee Criteria, and serve as Fee Determination Officials (FDO) on Performance Evaluation Boards (PEB), which are used to determine the amount of award fee the Center's key suppliers receive as a result of their performance.

1.1b Evaluating and improving Goddard's leadership system

The Senior Executive Leadership of the Center uses both formal and informal assessments to receive feedback on the leadership system's performance. The primary method of assessment is through formal performance reviews. The Senior Executive Leadership evaluates the Center's senior managers in their midterm and annual performance reviews based upon their performance in areas of critical and strategic importance to the Center. Individuals receive both formal and informal assessments of their leadership effectiveness during these reviews. Members of the leadership team are evaluated by the Center and Deputy Center Directors under similar criteria. Mr. Rothenberg and Mr. Diaz are formally evaluated by one of our key customers, the Enterprise AAs at NASA Headquarters, based upon their leadership in guiding the Center toward achieving agency goals.

Informal assessments of Goddard's leadership are received during the many one-on-one meetings which occur between the leadership team and our key customers and stakeholders. An excellent example of this is the regular Board of Directors meeting between the Center Director and the key Enterprise AAs for Goddard. This meeting is conducted for the purpose of providing guidance to the Center.

Leadership training is an important facet of the Center's leadership assessment. The Employee and Organizational Development Office offers both on-site and off-site training which includes courses at the Brookings Institute, the Federal Executive Institute, and the Office of Personnel Management. The Center retreats attended by members of the leadership team frequently have education components dedicated to leadership topics and training. Over the last six years, Executive Council retreats have included such eminent speakers as Peter Vaill, Ken Brosseau, James Champy, and Michael Tatham.

All employees are encouraged to participate in available training opportunities. Goddard has developed two in-house leadership curriculums, the Goddard Leadership Education Series (GLES) for supervisors and the Goddard Leadership Program (GLP) for nonsupervisors. Both of these courses provide opportunities for the workforce to interact with Senior Executive Leadership and to receive feedback on their leadership skills.

The Flight Projects Directorate, recognizing that a significant percentage of its senior managers were to become eligible for retirement in the near future, developed a formal program in 1990, the Project Management Development Emprise (PMDE), to train Goddard's future project managers. PMDE is now being used as a model for similar programs at other NASA centers. In each of these programs, GLES, GLP, and PMDE, the Center's leadership team is directly involved in the leadership training of the Center's workforce.

Finally, the objective feedback that the Center receives from applying for awards, certifications, and competitions is used by the Senior Executive Leadership to establish actions to rectify any inadequacies which are identified during the process.

1.2 Leadership System and Organization

Goddard's leadership system, consisting of the leadership team, senior personnel, managers, and supervisors, is committed to achieving the highest levels of customer satisfaction. Expectations, goals, and values are clearly communicated and integrated into the everyday workings of the Center.

1.2a(1) Goddard's Centerwide commitment to customer focus and high performance

The expectations of Goddard's customers, whether they are the Headquarters Enterprises, scientists, or the American people, can be summed up in the words of the NASA Administrator, "...faster, better, cheaper..." The Center Director took this concept, placed it into the proper context, and developed his improvement initiatives. The Center's leadership system is now putting these and other customer-based initiatives into action.

- Refocus the Workforce

In keeping with the results of the NASA Zero Base Review, Vice President Albert Gore's National Performance Review, and the current and future fiscal environments in which Goddard must operate, the Center has undertaken an effort to redirect the existing civil servant workforce into areas with an emphasis consistent with the roles and missions assigned to Goddard. Managers and supervisors are responsible for assisting employees in recognizing and developing strengths and career path goals, and encouraging them to apply for new opportunities within their capabilities. Supervisors and managers are responsible for enabling these employees to succeed by serving as mentors and providing developmental assignments. Training, both technical and career development, is being provided to assist the workforce in taking advantage of these opportunities in new and different career areas which are critical to the future success of Goddard.

- Enhance Scientific Leadership Role

Goddard has demonstrated a long history of scientific leadership for the nation. Recognition of this can be shown by its ability to staff positions within the Center with scientists of the caliber of Dr. John Mather, winner of the John Scott Award, one of the nation's most prestigious science awards. The Center is taking great strides to further enhance its scientific leadership role for the nation. With the creation of the Associate Center Director positions for Space Science and for Mission to Planet Earth, the Center now has dedicated leadership positions for Goddard's two customer Enterprises at the Center Director level. Goddard has established Joint Centers of Excellence with many of the top scientific institutions in the country including the Massachusetts Institute of Technology, the University of Maryland, Scripps Institution of Oceanography, the University of Colorado, Stanford, University of California–Berkeley, and Wisconsin University. These collaborative partnerships allow the Center and the academic institutions to exchange personnel and provide access to each others' intellectual and physical resources such as scientists, laboratories, and technologies.

- Increase Partnership with Industry, Other Centers and Agencies

Goddard is currently engaging in a number of collaborations and partnerships with other centers, agencies, and industry. The Goddard Executive Council is working with JPL, Ames and Langley Research Centers, Marshall Space Flight Center, and Johnson Space Center to conduct personnel exchanges, jointly improve processes, and take advantage of "best practices" and "lessons learned." Goddard is a member of an alliance between NASA and Department of Defense (DoD), undertaken to increase the efficiency and utilization of the nation's existing space environmental simulation facilities. Goddard is investigating collaboration opportunities with DoD laboratories in order to reduce areas of research and development redundancy and to gain from their experience. Goddard is partnering with numerous industry representatives such as CTA and TRW Corporation for the development of small spacecraft, and Space Systems/Loral for Global Positioning System (GPS) technologies. Goddard has signed a Space Act Agreement with Litton for the development of advanced gyroscope technology. The Center's first "New Millennium" spacecraft is being developed by an Integrated Product Development Team consisting of partners from academic institutions and industry.

- Increase and Stress Outreach/Inreach

Outreach and inreach, as pursued by Goddard, means increasing the knowledge of NASA's and the Center's impact on society. Our strategy is to emphasize two-way communication in three areas; education, technology transfer, and public awareness. The Center Director established an Education Council with representation from each of the directorates on the Center. The Council is responsible for establishing criteria for education programs, reviewing existing programs, and evaluating proposals for new programs. The Center Director has also hired a Special Assistant for Outreach to provide guidance to and coordination for the communications efforts of the Public Affairs, Education, and Technology Transfer Offices. Supervisors and managers are responsible for ensuring that time is made available for employees to interact

with the public in order to enable greater public awareness. This includes speaking at elementary and secondary schools and civic organizations, and volunteering at local science fairs and center outreach activities. The transfer and commercialization of the Goddard-developed technologies is a major focus of the Center and demonstrates another important aspect of the Center's public responsibility commitment. The Goddard Strategic Plan calls for the Center to transfer technology to the Nation's industrial base by establishing and maintaining avenues for the infusion of new technologies. The Center utilizes integrated teams of scientists, technologists, and systems developers from government and industry to identify and select, develop, validate, and infuse new technologies into U.S. industry.

- Develop Competitive "New Initiatives" Capability

In 1993, Goddard established the New Business Committee (NBC) to review the Phase A (preliminary studies) study plans for scientific and programmatic reasonableness. The NBC membership included the Deputy Directors of the Sciences, Engineering, Mission Operations, and Flight Projects Directorates, and the Chief of the Resources Analysis Office. The Goddard Leadership Team also gave the NBC the added functions of prioritizing new business opportunities, which are consistent with Goddard's Strategic Plan, and reviewing the current state of the Center's resources in order to better allocate the available resources. The Center has also created a New Initiatives Team (NIT) to assist the NBC by serving as a point of contact for potential partners, ensuring that the right talent is used during early business opportunity assessments, and providing decision packages to the NBC.

- Identify and Implement "GSFC 2005" Center Organizational Structure

Goddard is currently undergoing a "business reengineering" effort in order to achieve the manpower ceiling targets and realignments set forth by the Zero Base Review. This effort emphasized reducing the size of our infrastructure, eliminating overlap, and increasing value-added work to the customer. Wallops Flight Facility, for example, is reorienting its workforce following the NASA Headquarters decision to transfer its research aircraft to Dryden Airfield, and is entering into reimbursable agreements with the Navy in an effort to establish a commercial launch facility. The Mission Operations and Data Systems Directorate (MO&DSD) has consolidated its two largest systems engineering and mission operations contracts to reduce overlap and inefficiencies. Also, in accordance with the recommendations from the National Performance Review, the directorates on the Center are reducing middle management layers. One example of this is the reorganization of the Engineering Directorate which resulted in an increased employee to supervisor ratio from 6.5:1 to 10.4:1. The Flight Projects Directorate transferred its engineering personnel below the Branch Head level to either the Engineering Directorate or the MO&DSD, resulting in a center where engineers physically reside in the engineering directorates, thus enabling them to further refine their engineering skills. At the same time, future Projects assigned to or won by the Center are being managed by the Flight Projects Directorate, allowing the Center to benefit from the experience afforded by a senior management organization.

Supervisors are especially crucial in ensuring that employee goals align with organizational goals. A tool that is in use at Goddard to ensure that this happens is the Individual Development Planning (IDP) process. Supervisors use the IDP process as the framework for discussions with employees on specific skills and knowledge needed and to determine which training opportunities and job experiences are available to satisfy those needs. Supervisors also use the written document resulting from the IDP process to track employee developmental progress.

Goddard's suppliers are full partners in the Center's success. Their commitment to customer satisfaction and continuous improvement is evident in all aspects of their business relationship with the Center. Many of Goddard's major suppliers are members of the Goddard Contractor Association (GCA). GCA members compete for the annual Goddard Contractors Excellence Award. This award is a means of stimulating excellence among the contractor community and infusing good practices into internal Goddard offices.

1.2a(2) Effective communication and reinforcement of values, expectations, and directions to the Goddard workforce

The Goddard Leadership Team is actively involved in communicating and reinforcing the Center's values to the workforce and stakeholders through a variety of means, using written, electronic (video and World Wide Web), and verbal media. An excellent example of their commit-

ment is demonstrated by the establishment of "AA Days" which provide the Center workforce with an opportunity to interact with NASA Headquarters personnel. "AA Days" are broadcast to a centerwide audience over NASA Select TV.

The Leadership Team frequently conducts "All Hands Meetings" which are then followed by question and answer sessions. Many of the directorates hold similar sessions called "Town Meetings" which provide an opportunity for senior management to discuss a wide range of topics informally with the workforce.

The Goddard Leadership Team conducts "Director's Lobby Meetings" where the Center, Deputy, and Associate Directors along with various "Directors of" will visit a building and invite the employees to meet and talk with them. The Center Director also invests at least two hours per week to "walk the halls" in order to meet with the Center's workforce.

Employees, suppliers, and stakeholders are kept apprised of center activities, initiatives, and successes through the Goddard News which is published monthly, as well as through a variety of individual directorate newsletters, the Goddard Engineering, Scientists, Technicians Association (GESTA) Union Newsletter, the Goddard Employee's Welfare Association (GEWA) Newsletter, and the many World Wide Web (WWW) pages maintained by the Center.

1.2b Review of Goddard Centerwide and work unit performance

As discussed in section 1.1a, the Center has in place a number of systematic reviews which are designed to assess both the programmatic (cost, technical performance, and schedule) and operational status of the Center. These reviews provide an important mechanism for the leadership team to assess the Center's and individual work units progress toward achieving center goals and ensuring customer satisfaction. Examples of the critical performance parameters which are tracked include cost status versus plan, cost variances, cost to complete, liens against reserves, schedule status versus plan, schedule slack, corrective actions, technical performance budgets and margins, change order status, and civil service and contractor staffing levels.

Work units are first reviewed by their respective "Directors of" in monthly status reviews. These reviews focus on both technical performance and operational performance. Managers and supervisors present status, status -vs- plan, corrective actions in place (if necessary), financial, manpower, and travel status. In the case of development projects, managers also present performance metrics which are being tracked such as mass, power, and cost to complete. These reviews are designed to ensure that customer requirements are met. Any actions resulting from these reviews are updated weekly during directorate staff meetings.

The "Directors of" use this data, along with the weekly generated "Top Ten" problem lists, to present an overall status of the directorate during the weekly Executive Council meetings. More in-depth reviews occur quarterly where the same types of data are presented to the entire Goddard Leadership Team. These reviews provide the Leadership Team the opportunity to directly assess all of the critical financial and nonfinancial data for the Center's projects, divisions, and work units. The reviews also provide managers the opportunity to gain valuable input from the Center's Senior Executive Leadership, with which to improve their work unit's performance.

In addition to the previously described reviews, development projects at the Center are governed by a series of NASA Management (NMI) and Goddard Management Instructions (GMI). NMI 7120.4, Management of System Programs and Projects, establishes the management policies and responsibilities for projects at Goddard. The instructions establish the programmatic reviews which must be undertaken by the projects in order to assure the customers, throughout the project's life cycle, that the project remains programmatically viable. GMI 8010.1C, Flight Assurance Design Review Program, defines the policies and general procedures for the design review of projects at Goddard. These reviews are designed to assure that the customers technical performance requirements are met throughout the project's life cycle.

Centerwide reviews are conducted in accordance with the Agency's annual budget process and with existing functional management instructions. The annual budget at Goddard is $2.7B, 85% of which is for Research and Development (R&D) projects. Goddard currently develops seven different budget inputs and plans.

In 1991, the Center Director realized that one of the biggest challenges facing the Center was to maintain an aging facility with smaller budgets. He recognized that Goddard must plan for a conscious reinvestment and modernization of the institution. As a result, the Institutional Planning Committee (IPC) was established to facilitate the planning strategy, policy, and use of institutional resources

and to provide recommendations to the Executive Council and Center Director. The IPC is comprised of the Comptroller and the "Directors of" for six of the Center's directorates.

While Goddard actively tracks the Center's energy usage, manpower, materials, and capital, it has not in the past tracked asset productivity (as defined in the President's Quality Award criteria). It was not applicable to the way in which the Center previously conducted business. The Center is currently developing a full cost accounting prototype which will be tested in fiscal year 1997, with full implementation in fiscal year 1999. As Goddard transitions into a full cost accounting environment the appropriate mechanisms for tracking asset productivity are being developed.

Individually, the two science directorates on the Center have established metrics to track their progress relative to similar science organizations and laboratories by utilizing visiting committees and peer reviews. These metrics are reported in sections 5 and 6.

1.3 Public Responsibility and Corporate Citizenship

Goddard integrates public responsibility and corporate citizenship into all facets of the Center's plans, policies, and continuous improvement efforts. The Center takes pride in its success over the years of reaching out and into the local communities to provide much-needed expertise, resources, personnel, and educational materials. The Center is also extremely proud of its stewardship of the American taxpayer's resources, protecting their hard-earned investment in Goddard, and, through quality practices, providing an excellent return on their investment in the form of exciting new scientific discoveries and technology.

1.3a Integrating public responsibility into Goddard's performance improvement efforts

Compliance with legal and ethical requirements is a top priority of the Center's leadership team. With 90% of the Center's annual budget spent in the form of contracts and grants, Center leadership promotes widespread legal and ethical compliance and training for the workforce. Of the total population of 3,500 civil servants on the Center, 2,006 employees were classified as *having duties and responsibilities which required them to participate personally and substantially through decision or the exercise of judgment, in taking government actions*, and were therefore required to file Financial Disclosure Forms. The Center maintains 100% compliance with this requirement. In Fiscal Year 1996, 1,807 employees were required to attend Ethics Training and all supervisors and managers are required to participate in Sexual Harassment and Multi-Cultural Diversity training.

Goddard integrates public responsibilities into business planning and actively works with the local communities to assess how the Center's operations impact them. These methods include periodic meetings with officials from the City of Greenbelt, Prince George's County, the Prince George's County Economic Development Corporation, and approximately 30 local community organizations.

1.3b Leading as a corporate citizen in our key communities

Goddard's employees and the Center as a whole continue to lead as outstanding citizens in our key communities. Center leadership emphasizes and supports efforts in three main areas; strengthening community services, the environment, and education. The following examples demonstrate the Center's commitment.

Goddard actively supports the Combined Federal Campaign. Each year a different directorate coordinates and runs the Center's effort. In 1995, Goddard's Combined Federal Campaign goal was $390,000. Center employees gave $434,984 which was 111% of the goal, resulting in Goddard receiving the PaceSetter Award from the National Capital Area of the Combined Federal Campaign.

The Center is also involved in the Stevenson-Wydler Technology Innovation Act, which allows federal agencies to transfer excess research equipment to public and private schools. As of June 1995, Goddard provided research equipment valued at more than $15M to schools in Northern Virginia, the District of Columbia, and Maryland.

Goddard sponsors a food drive for the homeless, called "Harvest for the Hungry," where nonperishable food is donated at various pick-up points throughout the Center. This collection of food is performed under the auspices of the Office of Personnel Management's Baltimore Federal Executive Board, of which Goddard is a member. Center personnel have participated in this food drive for the last three years and the donations have increased 25% each year. Over 16,000 meals have been provided for the home-

less through the Center's efforts, ranking Goddard as the number three contributor in Maryland behind the U.S. Postal Service and the National Security Agency.

The Goddard Emergency Response Team (GERT) provides response and management of emergency incidents, including medical, fire, hazardous material, and specialty rescue. Through GERT, the Center's resources are available to the Prince George's County Fire Department.

A Mutual Aid Agreement is in place between the Wallops Flight Facility (WFF) and the Accomack-Northampton Fireman's Association for mutual aid in fire fighting. Wallops also has a hurricane/severe weather preparedness plan in place. This plan was developed so that Wallops can cooperate with tenants, other federal agencies, and local governments in planning and preparing for severe weather emergencies. The plan calls for Wallops to accept approximately 1,000 evacuees from the Town of Chincoteague and provide basic conditioned space and restroom facilities.

Corporate citizenship includes integrating conservation efforts into the Center's long range plans. On April 22, 1996, Goddard signed a Memorandum of Understanding with the Environmental Protection Agency to undertake a joint conservation project. This joint effort is Project Green Lights, which is a state-of-the-art energy-efficient lighting system. This system achieves two goals, saving money on the Center's energy bills and reducing the amount of pollution associated with electricity generation. When the entire center is upgraded (anticipated for the year 2002), Goddard can expect a cost-savings of over $600,000 per year, and achieve environmental benefit equivalent to planting 1,900 acres of trees or removing 970 cars from the road.

The Center also has an extremely strong recycling program. This program has resulted in a reduction of over 759 tons of waste, in the form of paper, cardboard, scrap metal, and aluminum and has earned Goddard over $40,000 and saved $35,000 in expenses.

Another indicator of Goddard's commitment to corporate citizenship is the quality of our education programs. In addition to the Teacher Resource Center located at the Goddard Visitor Center, Goddard has established Teacher Resource Laboratories in eight northeast states and the District of Columbia. These regional resource centers work in close cooperation with the Goddard Teacher Resource Center and serve as a clearinghouse for teachers to access Earth and space science videos, lesson plans, lithographs, slides, and related curriculum support materials. The Teacher Resource Center at Goddard annually supports 1,700 teacher visits, 1,000 phone inquiries, and 1,200 mail requests.

Goddard is currently conducting education programs in five areas; student support, teacher enhancement, curriculum support, technology applications to education, and systemic change. In all Goddard has 85 ongoing education programs; 37 Precollege (Kindergarten–High School), 36 Undergraduate/Graduate, and 12 Public Outreach/Education Linkage. Examples of these programs include the Maryland Ambassador Program, a partnership program with the Maryland State Department of Education and each of the 24 Maryland public school systems and NEWMAST, a partnership with 3 national science teachers associations where 25 teachers from across the country spend 2 weeks at Goddard with scientists and engineers designing a shuttle experiment. Goddard recognizes community service in its annual Honor Awards Ceremony, described in section 4.

The Goddard Visitor Centers (Greenbelt and Wallops) supported over 120,000 visits last year, including 280 school groups and 12,500 students.

Goddard is also actively participating in an international environmental education and science partnership program called "GLOBE"—Global Learning and Observations to Benefit the Environment. This program is a worldwide network of students, teachers, and scientists working together to study and understand the global environment. Goddard scientists work with the students to develop science objectives and analyze data, thus providing the students with opportunities to interact directly with leading scientists in this field. Over 2,700 schools in 32 countries have registered to participate in GLOBE.

Goddard selects and develops quality and operational data with dynamic criteria that derive from our customers' requirements and process needs, to achieve product excellence.

2.1 Management of Information and Data

2.1a Selection and management of data

Goddard selects and develops data and information needed to support operations, decision making, and to improve organization performance with dynamic criteria that derive from our customer requirements and our process needs. Goddard leadership provides high-level criteria that govern data selection at lower levels of the organization by establishing data requirements for formal review processes that relate to strategic objectives. Data compares the Center's performance against the strategic objectives and key drivers as well as measuring performance. The reporting processes all lead up through the organization to the Executive Council where the efforts are integrated and aligned with key business drivers.

Line managers select and maintain the data within their program and operational areas to support the strategic requirements reporting established by senior management. Each responsible manager sets criteria for selecting data and information that supports management of his mission, that identifies improvement opportunities, and that measures performance within these guidelines.

Goddard has three principal reporting processes that define the main types of data relative to key business drivers: Monthly and quarterly status reviews (MSR/QSR), the Design Review Program (DRP), and the Institutional Budget Review process.

All line managers report through the MSR process. Thus, the deployment of these reviews covers the total Goddard enterprise. The main types of data that programs and projects must report in the MSR/QSR are shown in figure 2.1 by category.

The selection of the data categories for the project MSR reviews is based on the need to align Goddard performance measurement data with the new organizational priority to implement the "faster, better, cheaper" project approach.

The categories of data covered in the MSRs of institutional and technical organizations address cost, schedule and technical performance, but the emphasis is unique to the priorities of each of those organizations. The data requirements laid on the responsible managers forces a selection of data that supports Goddard priorities and operations and links to strategic goals.

Review Subject	Subject Matter Content
Background	Program Description and Specs Baseline Budget and Schedule
Summary	Integrated Assessment Fever Charts "Top Ten" Problems
Technical	Signicant Progress Individual Problem Summaries Margin Status
Schedule	Master Schedule Milestone (Cum&Rolling Wave) Slack
Financial	Current Baseline Plan vs. Actuals Balance Sheet

Figure 2.1 The Program/Project Review Reporting Requirements Ensure Total Coverage of Performance.

The DRP provides a focused forum for selecting and analyzing project specific technical data. The objective of the DRP is "to enhance the probability of success of Goddard missions." The DRP consists of a number of specific reviews aligned with project phases. The main types of technical data required at each review differs depending on phase of the project.

The Institutional Budget Process provides the third process to report data. This is a "grass roots" process that analyzes data for improvement opportunities and for performance measurement in addition to preparing future budgets. The data selected to support this process is derived from user needs and includes both financial data and productivity measures.

Goddard employs several key mechanisms to derive data requirements, such as: reliability, rapid access, and rapid update, from user needs. A key mechanism is Goddard Information Resources Oversight Committee (IROC). This committee, chaired by Goddard's Chief Information Officer (CIO), consists of representatives from each major Goddard organization. It is a user working body and forum to ensure

that user feedback is directly considered at the highest management levels. It ensures an integrated view of the Center's Information Technology (IT) resources and systems and coordinates IT management issues and improvements with other NASA centers and with NASA Headquarters. The IROC coordinates IT activities across programs and organizations by aligning IT strategies, policies, and standards with the Center strategic direction, to support data requirements for institutional, program, and mission offices.

Centerwide reliability of and accessibility to resource data is provided by Goddard Random Access Management Information System (RAMIS), which provides online access to 70 data bases for over 1800 users. The architecture of the system makes data available to the users the instant it is loaded to the mainframe. The "real time" availability of financial data is crucial to Goddard operations. RAMIS also provides an *ad hoc* reporting capability in addition to online queries. In addition, customers can build data bases unique to their needs. The main data bases include fiscal, human resources, travel and contract information.

2.1b Improving the selection, analysis, and integration of data

Goddard evaluates and improves selection, analysis, and integration of information and data, to align with organizational priorities, through feedback from customers, users, and working groups and through analysis of results, processes, best practices, and lessons learned. Examples of customer feedback, such as measuring the volume of data requested by scientific clients, and customer surveys that measure the amount of time saved by Goddard targeting the data for customers, are in section 6.1b. Similarly, deploying lessons learned from one flight project to another, is discussed in greater depth in section 5.1c.

A significant change in the review process was to add a "balance sheet" data requirement to the main types of data required. The "balance sheet" shows liens (encumbrances and threats) on one side of the ledger and offsets (contingency and reserves) and potential descopes on the other side of the ledger. The intent is to have descopes identified for all projects so as to cover liens within project funding. This systematic approach to risk analysis gives project and Goddard management the opportunity and responsibility to manage to customer requirements within a fixed budget and schedule.

Another example of the ongoing process to improve data selection is the recent revision to the MSR reporting requirements. In this instance, Goddard senior leadership took steps to enlarge the scope of information the Center needs to accomplish the new strategic approach to project management. Cost and schedule became performance requirements instead of just "goals" for projects. The selection of data for MSRs was changed to ensure measurements of performance were aligned with the new Goddard strategy and key business drivers.

The institutional management process provides the data needed to ensure that the Center's institutional requirements enable and support Goddard's mission. Four key committees provide a focus for the institutional process. These are: the Strategic Planning Committee, the Institutional Planning Committee, the Facilities Coordinating Committee, and the New Business Committee. These committees use feedback from users to identify specific initiatives that enable and support Goddard strategic objectives. The committees also review the data used to make business decisions, and change the selection based on dynamic needs. Each committee uses detailed user and customer information to evaluate its process and performance for continually-improved decision making. The link for these committees is the Center Director and his Executive Council, where the Center's institutional requirements are integrated with technical program management requirements.

The breadth of deployment of our institutional systems is shown by way of the examples presented in figure 2.2. These systems are the Goddard core business infrastructure, supported by user and customer-oriented data sets to assess performance, analyze trends and issues, and plan process improvements. Several examples of data selection and use to improve process are described in section 6.2.

The Functional Management Self Assessment (FMSA) Program ensures self-assessment of the major functions at Goddard. Approximately 25 functional areas are fully assessed at least once every three years. This is a NASA-wide program and a designated National Performance Review Reinvention Laboratory, which may serve as a model for other government agencies. An example of one of these 25 functions is Information Resources Management (IRM), which includes mainframe and microcomputer computer systems, various libraries, directives, and correspondence. Seventeen groups comprised of managers and staff, that represent not only information-related users/customers but also outside participants, share learnings from similar assessment experiences. Criteria based on the NASA IRM Strategic Plan and industry best practices were used as a

Institutional Processes	Sample Data Sources
Human Resources Systems	❑ Training Accomplished ❑ EEO Profiles ❑ Skill Profiles ❑ Employee Awards and Recognition
Financial Systems	❑ Prompt Payment Act ❑ Obligation Rate Performance ❑ Accrued Costing ❑ 533 Reports Analysis ❑ Institutional Budget Process
Logisitics Management Systems	❑ Property Management ❑ Store Stock Management ❑ Transportation Management ❑ Program Logisitic Support
Acquisition Systems	❑ Undefinitized Contracts ❑ Small Business Performance ❑ Contract Lead Times ❑ SEB Process Times ❑ Award Fee Results ❑ Competitive Awards
Facilities Coordination Process	❑ Space Allocation ❑ New Construction Developed ❑ Housing Plan
Information Resources Management	❑ IRO Committee ❑ GSFC Center Network ❑ Software Eng. Lab Models

Figure 2.2 The Vital Management and Performance Data Provided Through the Functional Processes and Systems that is Analyzed for Performance and Process Improvement.

basis for the assessment. The data from these assessments are presented to the Goddard CIO, for linkage to Goddard's strategic plan. The results of the functional assessments Agencywide are used at NASA Headquarters for comparative assessment and Agencywide functional management improvement initiatives.

2.2 Competitive Comparisons and Benchmarking

2.2a Selection of benchmarking and competitive comparison data

The Goddard approach to selecting and using benchmarking and comparative data derives from customer requirements. The need and priorities for obtaining benchmarking and competitive comparison data are determined individually by the responsible Goddard managers.

Goddard uses two basic approaches to benchmarking and competitive comparison. The first approach applies to one-of-a-kind or prototype spacecraft, instrument development, and science and laboratory work. This first process is managed by the Resource Analysis Office (RAO) at Goddard. The RAO functions as an independent office that provides programmatic, technical, and comparative cost data and develops resource estimates to Goddard projects and to external customers. For example, U.S. government agencies and foreign government customers seek assistance and data from the RAO. For 20 years, the RAO has collected and analyzed over 30 years worth of data and developed over 50 models for estimating resource requirements for new start missions. The data have resulted from all the major inhouse and out-of-house projects at the Center, as well as from projects at other NASA Centers, from DoD, and from commercial aerospace firms. Every new activity at Goddard, from small Principal-Investigator class instruments to large observatory-class instruments, has RAO data and models available to establish a comparative baseline for the project. The discipline of this system provides a standard that new projects can use to assess assumptions, conditions, and proposed costs. The RAO continually upgrades its models to incorporate new technologies and approaches. The most recent RAO development is a model designed to analyze technical, program, and resource parameters of the new family of small spacecraft that epitomize the "faster, better, cheaper" philosophy now emphasized within NASA.

Peer Reviews (discussed in sections 5 and 6) are also an invaluable tool for assessing and improving our products and processes, and for serving as comparisons with world-class products and processes.

The second approach to benchmarking is deployed in the institutional support areas. Goddard, in conjunction with NASA Headquarters, reviewed the acknowledged leaders in facilities maintenance and selected three private firms to visit for fact finding. These were Disney, 3M, and DuPont. Data on processes as well as performance were acquired. Based on these data, Goddard synthesized an approach that was tailored to the unique maintenance requirements at Goddard. The Reliability Centered Maintenance (RCM) system was thus designed and implemented, resulting in more proactive, reliable, and less costly maintenance operations at Goddard. Benchmarking data from the Construction Industry Institute is used for benchmarking performance of construction of facilities projects at Goddard. The primary criteria used by the responsible Goddard managers to select comparison

data from within and without the organization must meet two tests: does the data relate to a key and fundamental activity and does the data represent at least "best in class" performance.

Stretch goals for new science and new technology flow down from the Center's top-level stretch goals established in "GSFC 2005" discussed in section 1.1a and shown in Table 2.1. All new Goddard activities are scrutinized for their ability to support these goals. While the goals of any single project may not precisely match all the measures, projects must in aggregate support them. Once the project is underway, the regular MSR/QSR reporting process provides performance checks to strategic goals.

Table 2.1

GSFC 2005 STRETCH GOALS			
Objective	1990-1995	1996-2000	2001-2005
Avg Cost of Flight System Development	**$450M**	**$190M**	**$80M**
Avg Development Time	**8.5 years**	**7.9 years**	**3.0 years**
Annual Flight Rate	**2.8 Launches/ year**	**5.8 Launches/ year**	**13.8 Launches/ year**
% Budget Spent Commercially	**7%**	**16%**	**26%**

2.2b Improving the benchmarking data selection

Goddard improved data selection by conducting two studies. The Engineering Directorate and the Mission to Planet Earth (MTPE) Program Office both studied commercial practices used by a number of small spacecraft developers to determine how Goddard processes could be improved to meet the new objectives. The conclusions of these studies are discussed in section 5. Implementation of the recommended benchmarking studies were applied to the implementation of new management practices in the LANDSAT Project, which resulted in the efficiencies that reduced project staffing by 25% and contractor support staff by 20%.

The Institutional Budget Process is an example of how Goddard uses a cyclical process to improve the quality and adequacy of data. Competitive comparisons are made between directorates performing similar functions. Goddard institutional budget performance is also compared to other NASA centers during Headquarters reviews. The Headquarters review includes such comparisons as productivity and rate of improvement among the centers.

The Functional Management Self-Assessment process described in section 2.1b provides insight into where performance can be improved. The functional assessment process also identifies where the data that measures comparative performance is inadequate.

The "lessons learned" process described in section 5.1c is also a significant method used for improving organizational operations and performance. The lessons learned from one project may not apply one-for-one to another project, but the cumulative effect of the lessons learned from many projects provides an assessment capability with a strong accurate historical perspective for continual improvement in project management.

2.3 Analysis and Use of Organization-level Data

2.3a Data integration and analysis for reviews and decisions

A key factor in understanding our customers is determining to what extent we are satisfying their needs. Goddard customer needs are clearly defined by extensive and detailed requirements. Typically, customers define requirements early in the mission development cycle, and customers are equal partners in the development and review of metrics as discussed in section 5.1a. The MSRs at Goddard focus on customer requirements, and especially deviations from those requirements. When a review identifies a cost, schedule or technical deviation, project teams work with the customer to achieve a mutually agreeable resolution. Problems with the MSR for example, are resolved via the "Top Ten" problem process (section 1.1). Operational projects have performance requirements for which metrics have been defined and against which actual performance of the delivered product can be measured. The technical and institutional reviews report to Goddard management how successfully technology and business objectives are being met. These reviews also provide the baseline against which improvements can be measured.

Goddard recently instituted a new "Report Card" procedure that integrates the total performance (technical, schedule, and cost) data of key suppliers. Traditionally, Goddard reviewed the performance of a contractor on a project by project basis. The "Report Card" aggregates all performance data from a contractor, including performance as a subcontractor, into a single package. Goddard management reviews the global performance of the contractor in all roles which allows Goddard management to evaluate overall con-

tractor performance and make business decisions against Centerwide strategic goals.

An indirect but applicable metric of customer satisfaction measures the number of customers and the amounts of data they request from Goddard. Both measures have increased dramatically. A customer survey addressed amounts of time saved for the customers by improved Goddard data procedures. Customers saved between 6 and 12 man months in data handling. The results reported in section 6.1b are direct indications of increased customer satisfaction.

Operational performance and improved organizational capabilities have been achieved in a number or areas. The education level of our workforce is regularly analyzed to ensure we can build and maintain high performance work units. The training metrics discussed in section 4.3a, show a steadily increasing trend in number of employees trained, the ratio of training instances per employee, and an increase in overall training budget. Another human resources management goal, low turnover, provides substantial benefits. The metrics show that Goddard has had the lowest turnover rate compared to other federal agencies in the area over the last several years.

Goddard's heritage is to build some of the most technically advanced spacecraft and instruments in the world. As shown in section 6.1c, Goddard spacecraft regularly exceed performance specifications, they last longer and they are more reliable than specifications require. As mentioned earlier, cost and schedule were once regarded as "goals." The new performance approach responds to what the customers want—that cost and schedule and technical performance are equal essential customer requirements to be met. And, as mentioned earlier, Goddard leadership revised the MSR data requirements to reflect the new strategic goals. Section 6.2c shows Goddard's steady and significant improvement in containing costs and meeting schedules of spacecraft and instrument development, and recent dramatic reductions in the overall costs of missions.

Systematic analyses of the institutional data presented in monthly reviews pinpointed areas where significant productivity gains could be made. Goddard automated and streamlined the payment process for small purchases and saved 3 workyears of effort. Another study showed that economies could be achieved by buying common parts for several projects at the same time. The implementation of this new process, coupled with a new process to reuse designs, produced cost savings of $4.2M. In 1991, Goddard had the worst record in NASA for prompt payment of vendors, as measured by the amount of interest paid on overdue bills. The Financial Management Division analyzed the data, identified the problems, and implemented process improvements that resulted in reduction in interest paid for late payments. Today Goddard has the best record among all NASA centers.

2.3b Relating data to performance

Goddard embarked on a "zero based" plan to dramatically reduce the time and cost required to implement missions, while still satisfying all mission objectives and customer requirements. To accomplish these goals, Goddard used systematic reviews of existing mission performance data, with models of future performance requirements, to make decisions which resulted in streamlined processes. To meet the aggressive schedules required to implement the new processes, efficiencies had to be introduced quickly and at every level. Major changes were introduced by processes such as Project Renaissance, used in the Mission Operations and Data Systems Directorate, to dramatically reduce the cost and lead time to develop mission ground systems. Two studies of commercial practices done by the MTPE Program Office and the Engineering Directorate led to changes in the way projects such as LANDSAT and Small Explorer (SMEX) are managed at Goddard with significantly smaller staffs.

Other significant gains in productivity have been made applying the techniques of the Flight Dynamics Division's Software Engineering Laboratory (SEL). The SEL has developed a technology that dramatically boosted developer efficiency and decreased system costs. A comparison of flight dynamics systems developed in the mid-1980's with those developed in the early 1990's shows great strides in code reuse, mission cost, reliability, and development cycle time. Average *code reuse* has increased from 20% to 80%. Typical *mission cost* has decreased by 57% *Reliability* has improved by 75% and error rates during software development have decreased from 4.5 to 1 error per thousand source lines of code. *Development cycle time* has been reduced by 38%. The SEL has received three awards—Agency level, national, and international—for its pioneering and outstanding contributions to software development.

Strategic Planning at Goddard has evolved over the last 10 years. Goddard's 1986 and 1989 plans recognized the need for more cost effective, relevant space research and outlined several broad strategies to increase Goddard's effectiveness. Goddard's 1991 plan was far more comprehensive and included action plans resulting in substantive process and product improvements. The Center's 1996 Plan establishes a new, far-reaching vision to be realized through strengthened leadership, outreach, customer service, and process excellence.

3.1 Strategy Development

3.1a Strategies and Operational Plan Development

Goddard's 1996 plan responds to recent, dramatic changes in government. Further budget reductions, growing competition, increased demand for scientific and technology advances, and national economic concerns were addressed in the development of our 1996 Plan. To meet these challenges, a new Goddard vision has been defined. Through leadership and outreach, Goddard will serve and enable the Nation's scientific and technology communities and draw upon this extended resource base to offset decreasing budgets and achieve new heights in science and technology excellence. A senior management team involving representatives from each of the Center's major organizations followed the structured strategic planning model shown in figure 3.1 to develop this vision and translate it into specific strategies for action.

The Agency's recent Strategic Plan provided overall science and technology goals for the field Centers. As discussed in the Overview and Leadership sections of this application, Goddard's Center Director defined several thrusts to "jump start" the process for implementing the Agency's plan. These strategic thrusts, together with the Agency's goals, provided the foundation for the Goddard Plan.

The "GSFC 2005" goals, also discussed earlier, define key customer requirements addressed by Goddard's 1996 Strategic Plan. They were developed early in the planning process to help align the Center, emphasize the need for measuring progress, and demonstrate the

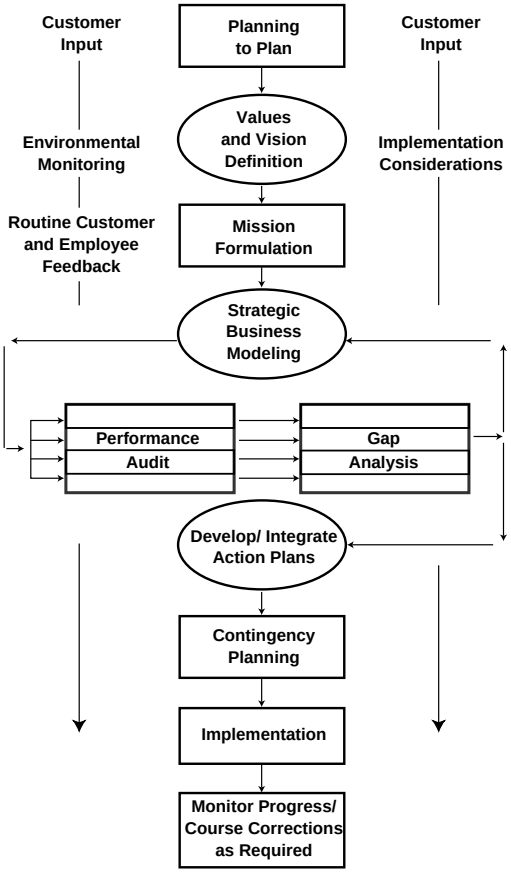


Figure 3.1 The Strategic Planning Process

Center's commitment to our customers. Specific customer requirements include the need for more flight opportunities, more cost effective missions, shorter mission cycles, and greater responsiveness to program changes and new scientific and technical opportunities. Strategies were subsequently developed to meet these peformance requirements and key metrics were defined to measure success.

Societal risk was addressed through careful consideration of the relevance of our work to our ultimate customer, the taxpayer. To maintain public support for NASA's programs, Goddard recognized the need to develop strategies to more effectively communicate the importance of Goddard's mission and demonstrate its relevance and impact.

An environmental assessment was conducted which included budget projections, analyses of other NASA Center and Federal Agency activities, an assessment of industry and academia capabilities, needs, and interests, and inputs from our stakeholders. This environmental assessment was key to defining our strategies and identifying resources with which to address customer requirements.

Although direct funding is anticipated to decline, other resources to accomplish our mission are projected to increase. Other government agencies, academia, and industry have developed impressive technological capabilities which are relevant to Goddard's mission. As a Federal Laboratory with specialized expertise developed over 37 years, Goddard is in an ideal position to stimulate synergy within the science and technology communities to enhance and more effectively bring these resources to bear on Earth and space science challenges.

Leveraging the best of the available external capability through partnerships allows Goddard to focus on requirements for which the Center's resources are best suited such as leading improved technology and science planning processes, leading the development of industrywide systems standards to facilitate the infusion of new technology, and focusing on high risk, high potential areas of research and development for which external sources are not available. This increased specialization will enhance Goddard's near-team competitive position, increase the Center's value to the larger science and technology communities, and lead to better management of technological risk.

3.1b Transition of strategies into key business drivers

Goddard's l99l Strategic Plan addressed the Center's key areas of responsibility and proposed numerous improvements relating to the development and application of new technology, spacecraft operations, workforce development, project management, and customer and supplier relationships. In the context of its new mission approach, Goddard's l996 Strategic Plan addresses these key areas by mapping them into the four specific business drivers shown in Table 3.1. An assessment of the Center's strengths and weaknesses in relation to the Center's vision, the need for agility in today's dynamic environment, and practical implementation considerations contributed to the development of Goddard's business drivers.

As an example, the Center's traditional approaches to technology development will no longer meet the needs of our projected science missions. Technology requirements will only be met by orchestrating a national capability which leverages the best of external sources. From this assessment, Goddard defined a business driver focused on enabling the nation's science and technology communities which will lead to new mechanisms for identifying, strengthening, and benefiting from resources external to Goddard.

Table 3.1 Goddard Business Drivers – 1996

Science and Technology Enabling: Provide a variety of services to enable the science and technology communities and, through strategic partnerships, apply external capability to meet mission objectives.
Leading-Edge Research and Development: Focus on high risk, leading-edge R&D initiatives to complement those available externally.
Program Management: Maintain a world-class program management capability to enable science and technology at the lowest possible cost.
Educational Outreach: Engage the educational community to enlighten and inspire the Nation.

The development of strategies to fulfill this new enabling role led to the definition of two additional drivers, Program Management and Leading-Edge R&D,which build upon Goddard's strengths.

Strategies to overcome one of Goddard's traditional weaknesses, the "marketing" of our products, led to the definition of a fourth business driver, Educational Outreach, to improve the dissemination of knowledge and increase the impact of Goddard's products.

3.1c Evaluating and improving the planning and deployment process

Progress of the action teams formed in response to Goddard's l99l Strategic Plan was monitored and evaluated on a regular basis using all of the Center's basic management processes from individual performance planning to reviews at all organizaitonal levels. Although a structured use of metrics was not incorporated to track progress, a formal evaluation report was produced in l994. Table 3.2 draws from this report to illustrate specific achievements.

The first steps in the development of our latest Strategic Plan included an assessment of the efficacy of the previous plan, interviews with the key individuals who led the previous effort, and discussions with our customers,

Table 3.2. Sample Strategic Plan Goals versus Accomplishments

Sample Recommendations from 1991 Strategic Plan	Accomplishments from 1994 Strategic Plan Update
• Clarify Directorate roles for EOS	• MTPE Program Office established
• Strengthen interdisciplinary planning during Phase A and Phase B of project development	• Enhanced staffing during early project stages of FUSE, TIMED, GAMES, HESP, and XTE • 37 project scientists and 21 deputy project scientists assigned to GSFC missions
• Incorporate lessons learned from past projects into Project Management	• Lessons learned database compiled for XTE and TRMM projects and incorporated into FUSE and MIDEX Projects
• Engineering Directorate to provide focus for systems engineering discipline development and expertise for in-house scientific instruments and orbital flight projects	• Established Systems Engineering Office • Publication of Guide to the NASA Mission Design Process and development of mission life cycle model
• Provide an excellent training and workforce development program	• 80% of GSFC employees attended training in 1992-93 • 14,000 training instances in short courses • 3,600 training instances in academic courses • Established centralized training facilities
• Link integrated institutional planning with new business decisions through the Executive Council	• Establishment of the IPC and the NBC to provide a strategic perspective to managerial decisions regarding Mission and institutional requirements

stakeholders, and employees at all levels. The importance of well defined organizational values was one key lesson learned. Values discussed in our l996 plan were particularly influential in the development of workforce and partnership strategies and in the definition of our critical success indicators.

We reviewed the strategic planning process and plans developed by the JPL, a principal collaborator and NOAA, a key customer. Goddard established goals for the Strategic Planning effort for use in evaluating the final product. The results of numerous Centerwide initiatives, such as the leadership and process assessments associated with preparing this application, were part of the "Performance Audit" and "Gap Analysis" steps of the Strategic Plan development and used to identify strategies for closing the gap.

Finally, an emphasis on implementation and tracking of progress from the very start of the planning process has resulted in Centerwide goals which are readily translatable into specific actions at the work unit level and an organized approach to measuring success, evaluating progress, and identifying and effecting further improvements across the Center.

3.2 Strategy Deployment

3.2a Specific key business drivers and translation of drivers into action plans

Goddard's key business drivers, shown in Table 3.1, "Goddard Business Drivers–1996," have been translated into specific Center strategic goals. Table 3.3 illustrates these goals, critical success indicators which are defined to organize the development of metrics, and the types of metrics which will be used to track progress against each goal. This model is being used to ensure alignment of scientific and technology implementation plans.

As an example, to carry out new technology management responsibilities associated with our "Enabling" business driver, Goddard has assumed leadership of two major Agency level technology management functions; Earth

Table 3.3 1996 Strategic Plan Goals

	Critical Success Indicators					
Center Goals	Quality	Productivity/ Efficiency	Outreach	Impact	Customer Service	Employee Satisfaction
	Metrics					
Serve as a National Resource for Earth and Space Science and Related Technology	Results of Peer Reviews	Productive Partnerships; Science/Tech. Data Delivery	GSFC PI's on Non-GSFC Missions	Membership on Scientific/Technical Committees	Customer Feedback; Use of Data Products	Employee Survey Results
Enable More Science By Increased Cost Effectiveness	Refereed Publications	Cycle Time Reductions; Decrease Mission Cost	PI's or COI's External to GSFC	14 Missions/Year by 2005	Missions Enabled; More Quality Science Delivered	High Motivation; Challenging Work
Enable Development of Innovative Technology	Patents, Awards	Technologies Infused; New Instruments	Technology Enabled/ Transferred	Economic Impact of New Technologies	Technology User Feedback, On-Orbit Anomalies	HighMotivation; Challenging Work
Enhance the Nation's Scientific Literacy and Technical Competence	Papers in High Impact Journals	Grad. Students; Visits/Lectures to Educational Organizations; Educational Value	Summer Faculty; Membership in Professional Organizations; Summer Students at GSFC	Papers in Popular Lit.; Study Aids Developed	School Feedback	Educational Survey Results
Sustain a Vital and Effective Workforce	External Awards	Training Instances	Employees Earning Advanced Degrees; Personnel Exchanges	Requests for Employment/ Personnel Exchanges	Number of Employee Grievances	Employee Survey Results
Maintain an Efficient and Capable Institution	Dollars Invested/ Capital Replacement Value	Overhead Reductions	Use of Non-GSFC Facilities, External Use of GSFC Facilities/ Capabilities	World Class Laboratories on Center	Facility User Feedback	Quality of Worklife Survey Results
Improve and Align Science, Technology and Business Processes	New Work Won/ New Work Proposed	Budget Development Cycle Time Reduction	Successful External Partnerships	GSFC/Agency Budget	Project Feedback	Employee Feedback

orbiting spacecraft technology management and the Agency's Small Business Innovation Research program, a program specifically designed to tap the resources of and enhance the Nation's small business research capability. In addition, the Center is establishing a program to ensure advanced scientific instrument technologies are developed on timetables commensurate with accelerated spacecraft technology development so that overall space mission cycle times can be substantially reduced.

Alignment of the various Goddard organizations and its contractor partners to overall Center strategies was a key objective in our I991 plan and the strategic plan was used as one mechanism to facilitate alignment. The subsequent development of strategic plans for key directorates reflects this alignment. Other actions included the formation of the New Business Committee to ensure the alignment of the Center's program with its stated mission, an Institutional Planning Committee to align the Center's institutional activities with its programmatic direction, and the Goddard Contractor's Association as a forum to promote alignment between the Center and its key suppliers.

Enhancement of the Center's end-to-end project management and systems engineering capabilities were two additional key objectives addressed in the Center's I991 Plan. Specific actions focussed on improved up-front project planning, streamlined program management, and an emphasis on teamwork within Goddard and with our suppliers. Implementation resulted in the completion of the X-ray Timing Explorer (XTE) spacecraft 8 months ahead of schedule and $35M under budget.

Further reductions in cycle time will be achieved through the use of new technology, synergistic partnerships, and concurrent engineering. Improvements are being implemented on the Mid-sized Explorer (MIDEX) and Far Ultraviolet Spectroscopic Explorer (FUSE) projects, with the redesign of ongoing projects such as the Earth Observing System Chemistry-I mission to reduce its cost by 50% and in the development of advanced weather satellites with enhanced performance at half of the current cost.

Twenty dedicated Action Teams contributed to the Strategic Plan and are now involved in implementation. The Center's Management Council, along with the Strategic Planning Team, participated in a three day "Bootcamp" training experience dealing with process redesign to facilitate plan implementation. Based upon this experience, the Management Council has undertaken the redesign of the Center's

process for making new business decisions, the promotion and reward process, and the mission development process. The assessment and redesign of our overall mission development process will highlight other high priority processes to assess and will provide the basis for realigning the organization to best achieve our strategic goals.

3.2b Projection of key measures/indicators of operational and quality performance

Because of the unique nature of each scientific mission, Goddard has historically used internal comparisons for assessing performance and driving continuous improvement. Comparisons with DoD, JPL, and commercial initiatives can, however, be made at a high level. Performance goals and associated metrics defined in our l996 Strategic Plan have been established to set new benchmarks in program management. Table 2.1 in section 2.2a illustrates the "GSFC 2005" goals which respond to our customers' requirements for more frequent and faster access to space at reduced cost. These goals are based upon anticipated process improvements and advances in technlogy. The "GSFC 2005" performance projections have been accepted at the Agency level and will be used to track the Center's performance. Related science and technology goals are being developed in the same pattern.

4.0 Human Resource Development & Management

The people of Goddard are the foundation for our product excellence. The continuous challenge to Goddard's Human Resource Development Management is to match policies, resources, and programs to the business plan of the Center and to react swiftly when the environment requires changes in that business plan.

4.1 Human Resource Planning and Evaluation

4.1a Key human resource plans are derived from Goddard's Strategic Plan

From a period of growth in the early 1990s, the challenge since 1993 has been to deal with Federal reinvention and downsizing which will result in a 12% reduction in civil-service and a 43% reduction in contractors by FY 2001. In this changing environment, planning and evaluation have become crucial. As a result, the Center's 1991 Strategic Plan listed six Human Resources objectives (figure 4.1) which served to guide the last five years of activity.

Budget cuts and changes in work design and workforce demographics are other areas of concern. Goddard currently has the highest average age and the most scientists of all nine NASA Centers. Hiring restraints, a declining workforce (figure 4.2) and future retirements will exacerbate the problem. In anticipation of critical skill deficiencies, the Center is conducting a skill mix assessment. When deficiencies are identified, redeployment or retraining of employees in those skills is occurring. With limited hiring capabilities, targeted hiring of scientists is a priority. Due to contractor downsizing, essential work is being shifted to civil servants while remaining functions are reduced or eliminated.

STRATEGIC PLAN WORKFORCE DEVELOPMENT GOALS

- Execute a recruitment and staffing plan for all disciplines and organizational levels that identifies, attracts, and selects quality candidates that are culture, race, and gender diverse; *[see section 4.1]*
- Provide a training and education program that addresses the developmental needs of individuals to perform their current jobs, that enhances skills for tomorrow's work and that provides individual career growth; *[see section 4.3]*
- Continue to expand supervisory and management training programs to provide those who plan and direct the work of others the skills necessary to manage people effectively; *[see section 4.3]*
- Provide recognition and reward for employees and groups who perform their work in an exemplary manner; *[see section 4.2]*
- Recognize those supervisors and managers who are effective in developing their employees' potential, building strong work teams, and involving employees in planning and work improvement processes; and *[see section 4.3]*
- Continue to use the full range of personnel authorities and pursue additional options to strengthen its human resource management practices. *[see section 4.2]*

Figure 4.1

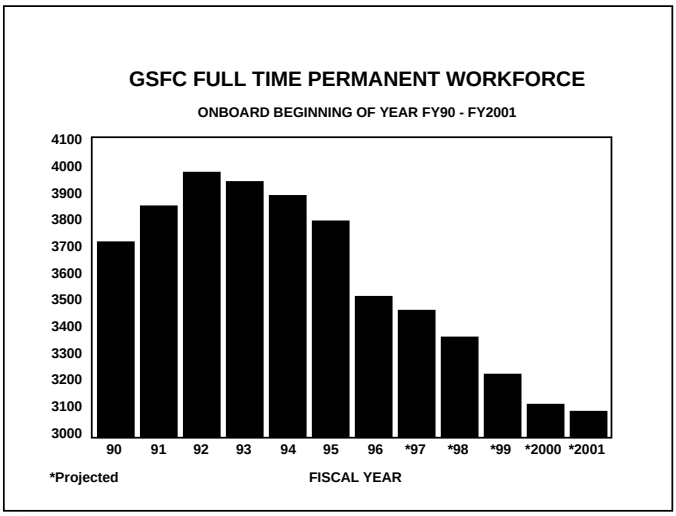


Figure 4.2

To deal with these and other issues, the Center's new Strategic Plan focuses on six future strategies: provide new opportunities to enable the workforce to develop and excel in the Center's core competencies; create an environment that sustains learning and creativity; foster an organizational climate in which employee diversity is a catalyst for creativity and productivity; provide reward and recognition for systems that link individual performance with Center goals, teamwork, and organizational performance; provide state-of-the-art tools to enable employees to fully use their talents; and create a full partnership with contractors.

Training is crucial in making these job transitions successful. As Center needs change, evaluation and analysis of training programs are conducted to meet evolving requirements. Additionally, there are several programs to help employees cope and prepare for these changes: 1) a career counselor is available to discuss career options; 2) a Career Transition Assistance Program is available to all employees and spouses to help with the transition into the private sector; and 3) a Retirement Transition Program allows employees to have a trial retirement period.

4.1b. Evaluating and assessing human resource planning and management

To assess employee well-being, manager/employee focus groups, culture surveys, exit interviews, employee meetings, and labor relations activities identify problems and opportunities.

To assess workforce diversity, the Center has initiated five Equal Opportunity advisory committees: Asian and Pacific Americans; African Americans; People with Disabilities; Hispanics; and Minority Employees and People with Disabilities at the WFF. A Women's Advisory Committee advises on gender related issues. These committees provide advice and guidance to management on issues affecting employment, advancement of their particular groups, and the general human resource environment. For example, the African American Advisory Committee was instrumental in working with the Office of Human Resources (OHR) to develop the Gateway program which provides advancement opportunities for clerical and technician employees.

The Center's Multicultural Advisory Team took the leadership in developing the Center's Diversity Management Plan. This published plan focuses on four key areas: 1) Management Accountability; 2) Work Environment; 3) Career Enhancement; and 4) Employment and Outreach. Each of these have a number of goals which foster the development of an environment that supports the full utilization of the Center's workforce.

In conjunction with the Center's managers, OHR works closely with Equal Opportunity Programs Office to achieve a culturally diverse workforce. Minorities and females comprised 38.6 % of the total workforce in FY89; by FY96, this rose to 45 %. Likewise, in senior level positions (grades 14 and above), the percent of minorities and females between FY89 and FY96 rose 11% and 20.2%, respectively. In Senior Executive Service (SES) positions, the percentage of minorities and females increased from 2.1% in FY89 to 13.7% in FY96. In spite of funding restrictions, the Center's priority is to continue to support on-the-job training programs (e.g., Cooperative Education Program and Cooperative Office Experience) that contribute significantly to our diversity.

The Center completed negotiations with its major union, GESTA in June of 1996. This is a broad scope agreement which covers most aspects of employment and working conditions and establishes a coherent, effective method for labor management relations. As a result of the most recent negotiations, labor and management responsibilities were clarified, grievance procedures simplified, and an innovative alternative work system implemented.

The Analysis Allocation and Systems Office assists management in allocating and analyzing Goddard's workforce resources by performing studies in areas such as attrition and trends in the workforce demographics. Insights gained through these analyses have been instrumental in dealing with workforce changes, forecasting attrition, and developing workforce plans that have allowed the Center to avoid reduction in force during this period of Federal downsizing.

4.2 High Performance Work Systems

4.2a Goddard's work and job design promotes high performance

Goddard's extraordinary record of mission success is attributed to its ability to bring together a diverse group of experts and specialists to create high performance work teams. The Center mobilizes and deploys its human resources in response to the specific requirements of each project or mission, keyed to the specific phase of the mission. Each of these phases requires different skills and numbers of employees. The nucleus of this work system is the project team, which is responsible for managing the overall project, maintaining continuity throughout the project's life-cycle, and providing a customer focus drawing upon various centers of expertise for technical and functional support.

The typical project team includes personnel with expertise in project management, flight assurance, engineering, mission operations, Earth or space science, and procurement. The core project team is supplemented by other technical experts as needed to form an expanded team. Resources are provided only as necessary. These experts are able to cross-fertilize ideas across projects.

In this way, Goddard continually searches for ways to improve its project teamwork system based on documented "lessons learned" gleaned from each completed project. For example, the X-Ray Timing Explorer (XTE) incorporated innovative teaming which contributed to its remarkable success ($35 million under budget and eight months ahead of schedule). Through vision and commitment, this empowered and badgeless team cut across organizational and civil-service/contractor boundaries to focus on the customer. Lessons learned from XTE will be incorporated into the very next project in the Explorer program, the Microwave Anisotrophy Probe.

The project team work systems promotes high performance through continuous process improvements. For example, through use of CPI Bootcamp®, process improvement teams within the Hubble Space Telescope (HST) Operations Project have resulted in a radically new operations concept for HST and the formation of integrated product development teams in February 1995 (see section 6.2b). Projected staff requirements have been reduced 60%.

Goddard actively supports employee initiatives and self-directed responsibility in a variety of ways. Some of the unique examples are the Goddard Senior Fellows and the Director's Discretionary Fund (DDF). The Goddard Senior Fellows was established to provide recognition to those who have attained the highest stature within their disciplines and have made outstanding contributions to the nation's space program. Sixteen members of the Center's workforce are designated Senior Fellows. Each Fellow receives $2,500 in travel funds to attend scientific conferences or colloquia. In addition, Fellows serve in a variety of advisory roles, such as providing recommendations to the Center Director concerning the allocation of the DDF.

The DDF creates opportunities for employee initiatives that appear promising. Goddard's most recent internal competition divided approximately $2 million among selectees from 135 separate proposals. As but one example, DDF support was used for the development of conical foil x-ray mirrors which will vastly improve the spatial resolution of x-ray telescopes. This technique is attracting world-wide recognition and has led to the development of a joint US/Japanese collaborative spectroscopic mirror on the Astro-E Mission scheduled for launch in 1999.

Opportunity for employee growth and development takes many forms. Over 30 Refocusing Opportunities (RFOs) have been developed in FY96 to help employees transition to new work assignments that match future workforce skill needs. These assignments include additional training and career development to assure these transitions are successful.

The Center also promotes growth through sabbaticals sponsored by the Research and Study Fellowship Program which provides either full-time graduate study or research at another laboratory or university. Frequently, these are

international and help form bridges to international partnership. Intergovernmental Personnel Act (IPA) assignments add to the complement of assignment and development opportunities. Since 1991, there have been over 20 IPA assignments designed to foster the transfer of experience and technology.

To avoid many of the limitations posed by the Federal qualifications and classifications system, the Aerospace Technologist classification system, which is unique to NASA, facilitates movement of scientists and engineers between specialties and provides the opportunity for multicareer paths. Both technical and managerial expertise are valued. One does not have to be a manager to have the opportunity to be promoted. In fact in recent years, nonmanagerial promotions at the GS14/15 level have exceeded managerial promotions.

The OHR works to maintain the currency of policies and programs through an active internal personnel management review process which over the last five years has evaluated 56 areas and adopted 223 recommendations. The OHR involves managers and employees from across the Center in improving processes. An example is the extensive grass roots review of the Competitive Placement Plan (CPP). The CPP is the Center's guidance for merit promotion opportunities. Six focus groups, consisting of managers and employees, were conducted to solicit ideas concerning how to promote merit selections within a simple, flexible promotion system. In addition, proposed plan options were presented to Goddard's unions for their input.

Once the plan was developed, a CPP brochure was specifically designed to communicate the plan in simple, non-bureaucratic terms. Also, briefings were held to educate the workforce. These efforts were in direct response to focus group feedback. This is but one example of a set of Human Resources Bulletins that have been developed over the years to communicate policies, procedures, and information in a clear, simple manner.

Even developmental programs for new professional employees, such as the Professional Intern Program (PIP), empower new employees to tackle problem areas and provide recommended solutions. More than 750 projects have been completed during the last six years. Projects have ranged from designing an electronic work request system for technical information services to the redesign and analysis of the Airborne Raman Lidar Structure.

4.2b Compensating and rewarding employees as individuals and teams

Awards support our high performance work systems. Awards recognize employees and teams for job performance and contributions. Space Act Awards recognize technical accomplishments, such as, patents and technical briefs. In addition, monetary awards recognize job performance during the performance rating year (Job Performance Award); one-time actions (Special Act Award for individuals or groups); outstanding job performance during the rating period (Quality Increase Award); and superior accomplishments or other personal efforts which contribute to the quality, efficiency, or economy of government operations. The funding for performance awards has increased 217 % since 1986 (figure 4.3) with the goal of providing managers greater resources to motivate and reward employees. Directorates are allocated budget authority for awards which are further allocated to organizational subdivisions. Time-off Award authority is provided to first-level supervisors.

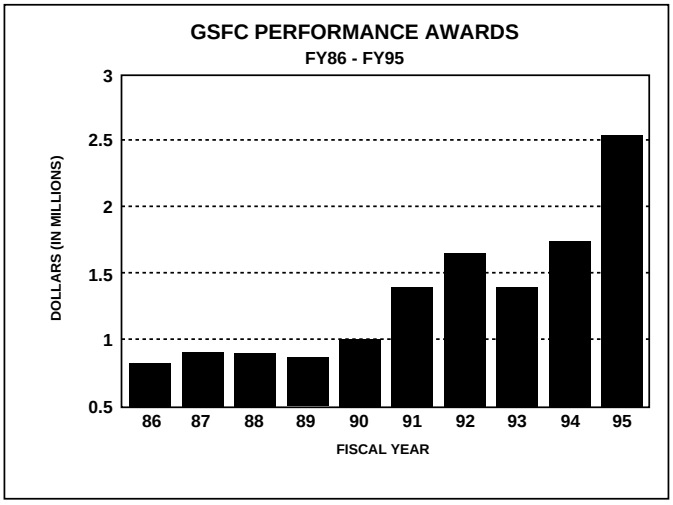


Figure 4.3 GSFC Performance Awards

Additionally, employees who have done an outstanding job and made significant contributions may be recognized through "Peer Award" ceremonies which operate within directorates. Contractors are eligible for many non-cash awards, are fully recognized as team members, and are also acknowledged by their government counterparts through peer recognition.

Other Honor Awards include Goddard's highest science and engineering awards: the John C. Lindsay Memorial Award for Space Science, the William Nordberg Memorial Award for Earth Science, and the Moe I. Schneebaum Memorial Award for Engineering. Each year, only one individual is selected for each category. Previous winners review their peers to determine future award recipients.

The Vice President's Hammer Award honors Federal employees who eliminate unnecessary bureaucracy to build a better government. In 1994, the Earth Observing System Distributed Information System Group received this award for creating an innovative operational system.

Other awards are given to employees throughout the year. Many of these are given by professional associations and honorary societies. Most recently, Dr. James Hansen, Director of Goddard Institute for Space Studies (GISS), was elected to the National Academy of Sciences for his distinguished and continuing achievements in original research. Election to membership is one of the highest honors that can be accorded a U.S. scientist or engineer.

Awards with formal presentation ceremonies are identified in figure 4.4. In 1995, there were 178 individual awards and 85 group awards (3,107 people) presented.

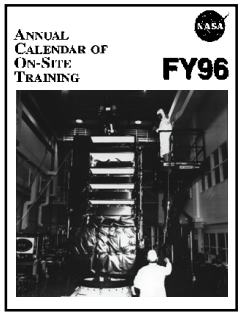
		Indiv.	Grp.
January	Safety Award	23	3
April	Secretary/Clerical	31	–
May	GSFC Honor Awards	62	40
May	NASA Honor Awards	59	19
June	Lindsay Memorial	1	–
September	Schneebaum Memorial	1	–
October	Centerwide Group Award	–	23
November	Nordberg Memorial	1	–

Figure 4.4 1995 Award Ceremony Calendar

4.3 Employee Education, Training, and Development

4.3a Building organization and employee capabilities

Goddard's complex mission is accomplished by a workforce that is equally complex, both technically and professionally. Goddard is a knowledge based organization in which education, peer interaction, and training each play a significant role in advancing the capabilities of the Center's workforce. Scientists and engineers (S&E): physicists; astronomers; meteorologists; oceanographers; geophysicists; mathematicians; electrical engineers; mechanical engineers; computer engineers; electronic engineers; aerospace engineers; and computer scientists comprise 60 % of the workforce. Various administrative and professional employees, technicians, clericals and wage grade personnel complement the S&E staff and comprise the remaining 40% of staff. Added to this mix are roughly twice as many of our contractor partners. With ever-changing technologies, new missions, organizational realignments and current limited hiring ability, meeting the education, training, and development needs of such a diverse workforce presents significant, but well-met challenges.



To create and sustain high-performance work units, Goddard provides an extensive array of innovative education and training services and facilities in direct support of its strategic human resources goals. The training curriculum is continuously updated based on periodic needs assessments to assure that our staff maintain capabilities in their respective fields. Needs are assessed through formal assessments, curriculum based analyses using the DACUM (Developing a Curriculum) process, focus groups, and most importantly one-on-one contact by the Center's training staff with the Center's managers and employees. As a result, employees can choose from among 420 on-site and thousands of off-site academic and short courses, as well as seven on-site academic programs and four upward mobility programs. Or they may select from over 400 self-paced courses, as well as instructional television courses, offered by the on-site Learning Center. The breadth and flexibility of Goddard's education and training approach has proven to be a highly cost-effective strategy for building organizational and employee capabilities. For example, the cost of on-site technical training is about 40% less than off-site training. Goddard's strong commitment to pursuing this strategy is re-

flected by increasing levels of funding for training (figure 4.5). This commitment has resulted in a higher proportion of employees trained from FY91 through FY95 (69 % vs. 95 %) and a higher ratio of training instances per employee (2.02 vs. 3.47).

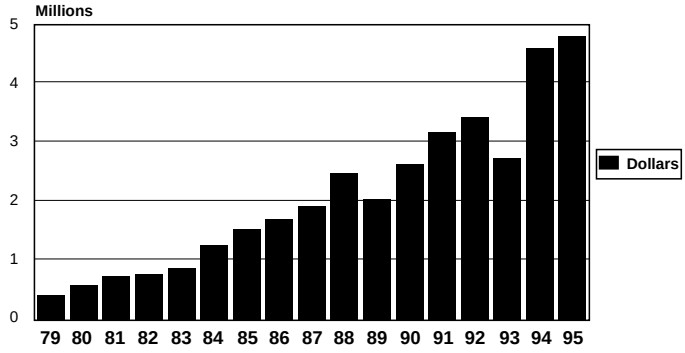
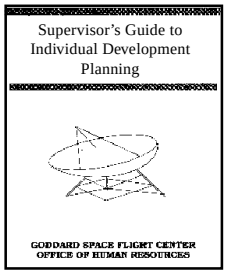
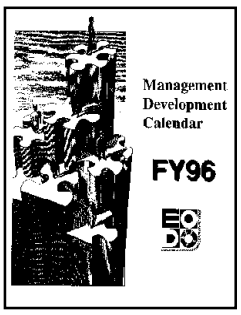


Figure 4.5 Training Budget FY79-FY95



Through the Individual Development Planning (IDP) process, employees and their supervisors together identify both training needs for improving current job performance and development needs in support of career goals and future organizational requirements. Developmental activities are based on particular needs. For example, with regard to formal training, the employee can select from among on-site courses in the following categories: scientific and technical, career management, secretarial and clerical, interpersonal communication, health and safety, computers, equal employment opportunity, procurement, total quality management and resources management.

Informal educational activities are also available on-site through an extensive program of engineering and scientific colloquia, as well as "Teas and Posters," seminars, and conferences sponsored by individual directorates. Also, a very active chapter of Toastmasters provides training in communications and presentation skills.



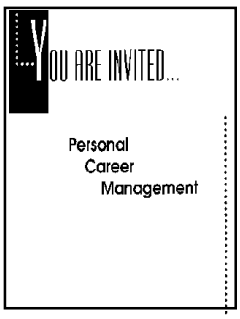
Supervisors and managers can attend on-site courses described in the Management Development Calendar in the areas of supervisory skills, team building, career development, conducting meetings, interpersonal relations, decision making, problem solving, managing conflict, project management, process improvement, time management, and stress management. New supervisors and managers complete a core curriculum of six courses which culminates in the 6-day residential Goddard Leadership Education Series (GLES) seminar. Since GLES was initiated in the fall of 1980, nearly 1000 supervisors and managers have attended. In response to the recent shift from supervisors to group/team leaders, a similar 6-day residential seminar has been developed as a nonsupervisory complement to GLES. Both seminars serve as a major vehicle for instilling organizational values, as well as developing leadership and teamwork skills. Additionally, Goddard actively supports its managers and executives in attending seminars sponsored by NASA Headquarters, the Office of Personnel Management (e.g., the Federal Executive Institute), the Brookings Institute, and the American Management Association. Over the past three years alone, 242 managers have participated in these programs.

Goddard sponsors individual employees in attending a wide range of off-site professional and technical short courses, academic courses and conferences.

Continuous Improvement (CI) training has been a component of Goddard's approach to providing high quality products and services to our customers. Goddard's senior executive leadership, managers and supervisors, and nearly 100 team leaders have been trained in Total Quality Awareness over the last three years. Additionally, Process Improvement, Leadership for Quality, and the Voice of the Customer are three other quality based course offerings. Nearly 300 members of intact work teams have completed a 3-day Continuous Process Improvement (CPI) Bootcamp®, which is now being used as the core training for process redesign teams within Goddard's current process management efforts. One of the early measures of CPI Bootcamps® effectiveness is the highly successful reengineering of the HST (see section 6.2a). Process action teams have access to a total quality library of training and reference materials. A number of courses are also offered in the areas of ISO 9000, in reducing space-mission cost and a specially developed course on project risk assessment, a key requirement when producing state-of-the-art spacecraft hardware.

Also, Goddard conducts functional training with extensive curricula in the areas of health and safety, project management, computers, Equal Employment Opportunity (EEO), procurement, and financial management. A full spectrum of developmental programs are deployed to assist em-

ployees in virtually every segment of Goddard's diverse workforce to enhance career development. In partnering with local universities, Goddard offers seven academic incentive programs that allow employees to take undergraduate and graduate courses. Three of these programs are on-site and result in Master's degrees (Master's of Science in Engineering Management, Master's in General Administration, and Program for Research and Education in Space Technology). Over the past 5 years, 13% of the workforce has participated in these seven academic programs. There are four upward mobility programs (for clericals, paraprofessionals, technicians and wage grade employees) and two work-study programs (for college students and high school seniors). Additionally, Goddard has two internship programs (Presidential Management and the Professional Intern Program for entry-level scientific, technical and administrative) and two executive development programs (SES candidate and project management).



Complementing these formal programs are additional resources to help employees further their careers. Twenty-four short courses are offered on-site that cover every aspect of career management, ranging from identifying one's career motives to preparing job applications or planning for retirement. Also, a career counselor is available for confidential one-on-one sessions with employees. A career library with self-assessment workbooks and reference materials is also used by employees.

Creating and sustaining high-performance work units requires more than addressing employee motivation, development, and progression issues. Goddard management also recognizes the importance of work group and organizational effectiveness, especially in this time of constant change. Consequently, Goddard deploys a cadre of Organizational Development (OD) professionals who team with managers and intact work groups in providing OD and consulting services in the areas of retreat support and facilitation, team building, organization assessment, strategic planning, leadership transition, partnering, conflict resolution, meeting facilitation, process improvement, process engineering, role clarification, and restructuring. Between 1992 and 1994 alone, 182 client groups benefited from the OD team's services. This team is heavily involved in Goddard's current process management and strategic planning endeavors.

4.3b Designing, delivering, reinforcing, and evaluating education and training

Goddard's employees and line managers are involved in determining specific education and training priorities and designing courses and programs through various training needs assessments and focus groups conducted by the Employee and Organization Development Office. In support of Goddard's excellence in technology and science, Centerwide technical and scientific training needs are assessed periodically. In FY96, a survey of 68 branch level managers resulted in 55 new scientific and technical courses planned for FY97. Also, intensive 3-day curriculum development panels were convened for the positions of Engineering Manager and Group/Team Leader. Once new training programs are developed, selected individuals from the target populations are included in the pilot test of programs, and revisions are made based on their evaluations. Ongoing course evaluations administered at all on-site courses and Learning Center courses provide feedback and ideas for new programs. For instance, 75% of the new courses purchased annually for the Learning Center are based on employee suggestions. Also, training needs within an intact work group may be identified as a result of an organizational development involvement.

The heart of the education and training delivery system is the 6000-square-foot Training Facility. This state-of-the-art facility was completed in early 1993 and represents the Center's strong commitment to training and development. The majority of on-site courses are held in the facility during normal working hours, and academic classes use the facility four evenings a week. Also, there is a computer training lab with 17 PCs in addition to conventional classrooms and the Learning Center. The Learning Center itself contains 11 self-paced learning stations for audio tape, video tape, computer-based training, and inter active video training programs, and two Instructional Television classrooms. Three classrooms in the facility are wired with the Picturetel system for distance learning. Many employees also attend short-courses and academic courses off-site at the many local colleges and universities. By using TRAINET, an automated training course da-

tabase for over 100,000 seminars, courses, and conferences, employees identify appropriate courses.

NASA's Management Education Center, located at the WFF in Virginia, is a first-class facility with 14,000 square feet and 70 rooms for residential seminars and retreats. Over 175 groups use the facility annually.

At times, the demand for Goddard-specific training exceeds the supply of qualified professional trainers. In FY95, Goddard developed an innovative approach for providing quality in-house instruction in technical and nontechnical subject areas. The Employee-Trainer Quality Instruction Program prepares functional experts to design and teach courses tailored to Goddard's mission and culture. Fifteen courses have been conducted to date.

Three of Goddard's developmental programs provide excellent examples of how knowledge and skills are reinforced through on-the-job application. The Technical Apprenticeship Program combines 2087 hours of on-the-job training with at least 208 hours of classroom instruction annually over a 4-year period to develop technicians in the areas of fabrication, optics, plastics, metal bonding and electronics. The PIP is designed to acquaint all entry-level scientists, engineers and administrative employees with NASA and Goddard missions and operations, integrate them into the workforce quickly, and prepare them for more complex and responsible duties. Required activities include an IDP, establishment of a mentor relationship, at least 40 hours of formal training, on-the-job experiences and completion of a project which interns describe in a written report and oral presentation to a panel of evaluators.

Project Management Development Emprise (PMDE) provides selected technical and administrative employees with the work experiences, training and guidance from a mentor necessary to assume key management positions on flight projects. The PMDE was established in response to the potential loss of flight project managers eligible for retirement, coupled with the fact that project management is a discipline in itself which requires specific training and experience. Since the program's start in 1990, 30 people have been accepted (about 5% of applicants). Twelve have graduated and 18 remain as active participants. The PMDE has been so successful that NASA Headquarters has modeled a similar program after PMDE, the Program Management Development Process, throughout the Agency.

Goddard's extensive education and training programs are evaluated on two levels. Written participant evaluations from on-site courses, seminars, and Learning Center sessions are used to provide feedback to instructors, to suggest potential course improvements, and to recommend new courses. For example, the GLES was revised extensively last year based on participant input. More in-depth evaluations are conducted to assess applicability of the training to the job and enhanced work unit performance. Through the use of written surveys, focus groups and individual interviews with past participants and their supervisors, important data is generated for evaluating the program's overall effectiveness. Such an in-depth evaluation in January 1995, was instrumental in changing the partnering university for the Master's in Science in Engineering Management program. In addition, the new university is modifying courses and designing two new courses specifically to meet Goddard's needs.

The senior executive leadership of Goddard views education and training as the key to proactively managing the technological and organizational changes confronting the Center as it prepares for the year 2000.

4.4 Employee Well-Being and Satisfaction

4.4a Maintaining a safe and healthful work environment

Goddard maintains a safe and healthful work environment by providing comprehensive programs in the areas of institutional safety, industrial safety, and emergency management. These programs are complemented by specific training in specialty areas which include courses ranging from Explosive Handling, Cryogenic Liquid and Compressed Gas Safety, Construction Safety, to First Aid training. One safety area of particular concern is the need to improve the skills of high voltage electricians. This need was identified as a safety concern and an intensive 1-year training program was implemented.

In addition, the Health and Safety office sponsors an annual Health Fair and publishes the "Wellness Star" (one of many Center organizational newsletters). To assist employees in making informed decisions concerning health benefits, an Open House is conducted each year to introduce employees to new plans and ask questions of health insurance providers.

4.4b Organizational support for employee well being and satisfaction

Goddard has made its employees a stakeholder in their own well being. Employees are given the opportunity to take advantage of services, facilities, and activities offered. The Health Unit offers free annual physicals, and a modern fitness facility. Over 600 employees are enrolled in the fitness facility. Employees are encouraged to participate in the annual President's Sports challenge and our Centerwide Fun Run.

The Goddard Employee's Welfare Association (GEWA, est. 1961) at Greenbelt and Wallops Employee's Association (WEMA, est. 1981) at Wallops conduct activities to foster and promote social, athletic, educational, cultural, and welfare interests of its members. The GEWA/WEMA support various activities, such as, scientific and engineering colloquia, various EEO and multicultural programs, holiday functions, Red Cross blood drives, and over 50 special interest clubs. Additionally, the Goddard Day Care Center (est. 1972), was the first of its kind and became a model for the Federal Government. Since inception, nearly 1,400 children have benefited from Goddard's Day Care Center.

Another example of a model program was NASA's own life insurance program, NASA Employee Benefit Association. Goddard's chapter has played a leading role in enlarging the coverage over the years.

To foster a high performance workplace, Goddard is currently offering such flexibilities as part-time work, and a unique and innovative Flexible Work Schedule (FWS) has been implemented. The FWS allows an employee to creatively structure the work week around a very simple set of guidelines and avoids the complexity of many flex programs.

In addition, the Center is taking great strides to provide an accessible workplace especially for those with disabilities. A needs assessment was performed which identified facility areas that required improvement. These were then prioritized, and an action plan was implemented. In FY95-96, over $1.5M was spent on modifications.

The Leave Transfer Program permits fellow employees to support each other's well-being. Starting in 1988, Goddard implemented a Leave Transfer Program through which leave donors at Goddard may donate annual leave to leave recipients who are experiencing a medical emergency. From 1988 through 1995, 2,517 donations have been made with 55,356 hours donated to 309 recipients.

Participation in external outreach has always been high by Goddard employees in reaching out to community schools as well as to employee hometowns throughout the country. As an example, a Goddard contractor father and civil-service daughter participated in a middle school Space Week in California conducting 27 classroom hands-on lessons. Goddard's employees volunteer their time and participate in Visitor's Days, Open-Houses, National Engineer's Week, and Take Your Daughter to Work Day. Goddard's Traveling Exhibit Program, which has included 107 exhibits, reached over 500,000 people last year. The Center maintains an active Speakers Bureau, and other outreach activities.

4.4c Evaluating employee satisfaction, well being, and motivation

Goddard provides challenging work to a highly motivated workforce. Analysis indicates that the turnover and sick leave rate as compared to other Federal agencies in the area is significantly lower. For example, the turnover rate for Goddard in FY92 was 5.8 and other agencies 12.7; by FY95 Goddard's rate rose to 12.1 (due to buyouts) and the other agencies rose to 14.9. The latest comparative Agency sick leave data (1994) was 8.6 compared to Goddard's 7 average number of sick days used per year. Goddard is a career employer whose employees are committed to the Center's mission. An indicator of this is the status of retirement eligible employees. As of June 1996, 13.9 % of employees are eligible to retire. Of this group, over one-fourth have been eligible to retire for over 5 years.

In addition to the Center's formal grievance procedure, an Alternative Dispute Resolution (ADR) process is utilized. This process is more advantageous to all parties because it resolves issues faster, saves money, and helps parties resolve issues raised in a way which promotes effective future working relationships and organizational health. Of the three cases referred to the ADR, all have been settled without proceeding to a formal grievance mechanism. Goddard's program continues to be a model for the Agency.

A recent survey conducted by the Office of Personnel Management was the Personnel Services Customer Survey. One of the areas of measurements was employee satisfaction in training. NASA had, overall, the highest rated training in the Federal Government. Goddard exceeded the government average on 13 of the 15 questions and exceeded the NASA average in 9 of those 15 questions. This information is being used to help focus on weaker areas to build an even stronger program.

Goddard has an effective network of processes that have evolved to meet its needs in an increasingly competitive space technology and science market. Focused on meeting requirements for unique missions, they are comprehensive, flexible, and successfully enable the science research process.

5.1 Design/Introduction of Products/Services

The starting point for the Goddard mission cycle is a scientific customer with a need, who establishes the science objectives for a new mission. The process flow diagram (figure 5.1) illustrates customer involvement in all Goddard key processes—Science Research, Mission Definition, Mission Development, Mission Operation, and Communication/Outreach. Throughout the mission definition, development, and operations processes, the customer is asked to examine the concepts, designs, and data products to ensure that his/her science objectives will be met. A common element of Goddard processes is the continued participation of all stakeholders, providing assurance that the scientific objectives are always within the forefront of the activity and optimized within constraints.

Guidelines for process design, review, and management are provided in NASA and Goddard Management Instructions and Handbooks. They provide instructions and guidance for use in the development of mission plans and throughout the implementation phase. Further detailed guidance is provided in documentation prepared by Goddard Directorates.

A fundamental concept implemented in the design of Goddard processes is to provide for flexibility and improvement. Guidelines are tailored to meet specific programmatic requirements and to optimize effectiveness. They also respond to changes in future mission requirements. Additional guidelines have been developed, for example, in response to the shift to smaller, lower-cost projects. A benchmark study to identify the industry's "best practices," was conducted by the MIDEX project, after visiting twelve small satellite builders. Many significant observations were made, enhancing Goddard's ability to competitively build the next generation of smaller satellites and instruments.

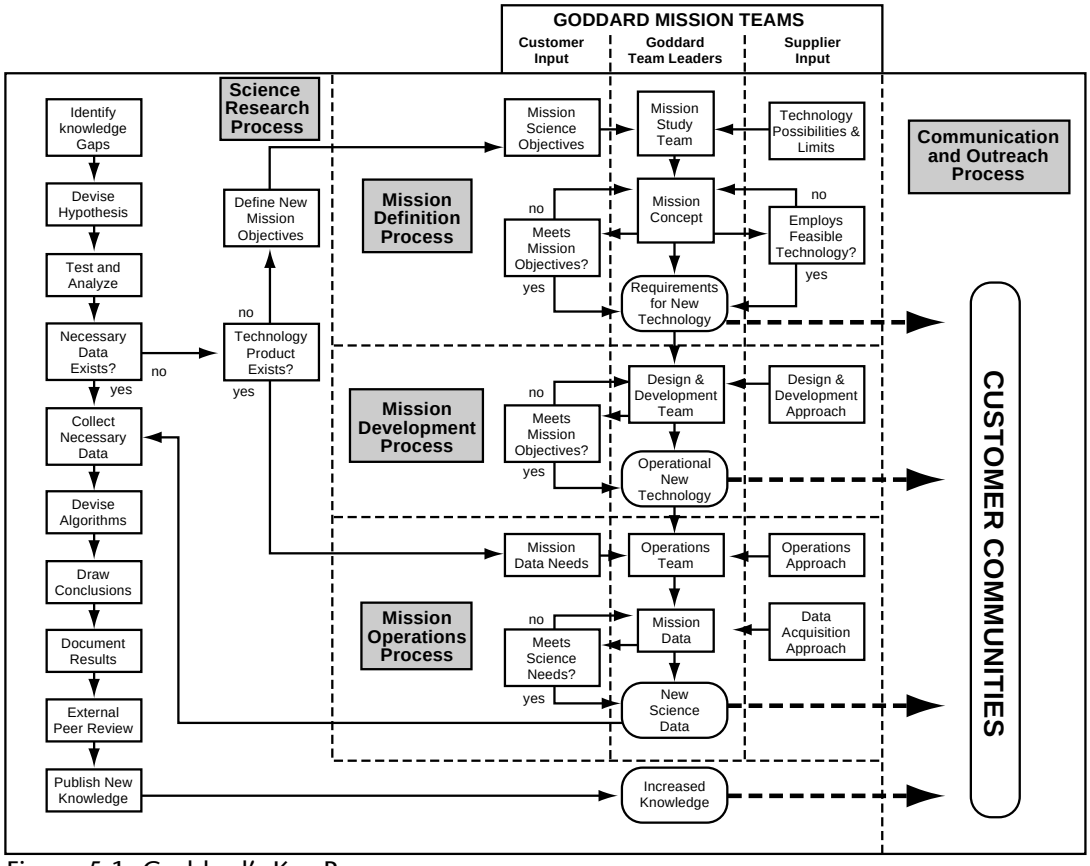


Figure 5.1 Goddard's Key Processes

5.1a Design of processes

Goddard uses a combination of integrated teams and directorates to gather the information required to design its processes. The participation of customers, suppliers, and process owners in the integrated teams provides the opportunity to achieve the best possible results at each stage of process development.

Product development starts with the Mission Definition process. The members of the integrated teams involved in this process can include scientists, engineers, and managers from government, supplier, and university arenas as appropriate, which are drawn from the customer base most appropriate to the project at hand. Team members feed in engineering, cost, integration, and management requirements. Inputs from these teams are transformed into the mission requirements necessary for the next step in the Mission Development process.

Additional customer input to the design process may come from the Science Panels and Working Groups representing the ultimate users of the data products. Their participation in workshops, conferences, surveys, focus groups, one-on-one conversations, seminars, and regular mission status reviews assures that products and services developed will provide all customers with optimal results.

Mission Teams focus on executing a specific science mission. These teams change in nature, size, and composition as the mission evolves. Team members are drawn from multiple Goddard directorates, as well as from customer and supplier communities.

Two broadly applied techniques that have met with success in ensuring early identification of concerns or opportunities for improvement are the following:

- Widespread use of Peer Reviews throughout the development process, providing critical examination and communication of approach and status between directorates and mission team members. Customer participation is encouraged for their inputs and information.

- Goddard teams with its industrial partners to maximize the benefit of government expertise and involvement. As Goddard downsizes, the teaming approach becomes more critical. More accountability is being placed on the contractors, with Goddard emphasizing insight and high value involvement and very little oversight of areas in which the contractor is most competent.

The National Performance Review's Hammer Award was given to The Earth Observing System Data and Information SystemGroup, for creating an operational system which allows customers to participate in program design.

Metrics which are established during mission definition and development are used across Goddard for performance measurement against cost, schedule, and technical performance requirements. For example, projects track significant metrics covering actual versus expected performance of schedule contingency, financial budgets, and projected problem areas. Customers participate in the development and review of metrics and as equal partners in the decision making process.

5.1b Design review and validation

One of Goddard's most important and recurring processes is project re-evaluation to answer the changing resource demands of the different mission phases. This is akin to what might be called a "production process" since our people "produce" our missions. As with most other processes at Goddard, an integrated team approach is used early on in the mission implementation phase to optimize resources. That approach is revisited periodically.

For example, our partnership management philosophy was embraced early on by the Geostationary Operational Environment Satellite (GOES) project, resulting in the 1995 Von Braun Award for Excellence in Space Program Management from the American Institute for Aeronautics and Astronautics. Based upon this history, the LANDSAT project employed these proven management strategies in downsizing and optimizing Goddard and contractor organizations at all levels. Customer representatives were physically located within the project area, and actively participated in decision making processes. Three working groups were established, drawing on the synergistic benefits of government, contractor, and customer contributions. Documents for NASA formal approval were reduced from typically well over 100 to 5. Team members assumed greater responsibility, with employee morale increasing as roles changed from "watcher" to "doer." Productivity increased through elimination of duplicate efforts, as detailed in section 5.2b.

5.1c Design evaluation and improvement

Designs and design processes are continuously evaluated and improved at Goddard, as part of becoming a competitive world-class organization. Customer participation in our integrated teams provides valuable insight into potential opportunities for improvement. As described in section 5.2a, all aspects of operation are targeted for analysis and improvement, in a completely objective team-centered environment.

The use of "lessons learned" is recognized as a valuable tool for process improvement at Goddard. Projects compile their lessons as a regular part of project documentation. The Systems Review Process, discussed in section 5.2a, ensures that lessons learned are carried forward into new projects. Lessons are implemented within and across projects. For example, the Goddard managed XTE project has recently provided valuable learning that has been used in both the MIDEX and FUSE projects.

An excellent system for the documentation and dissemination of lessons learned has been created by the EnviroNET Project, which resides at the Engineering Directorate at Goddard. Developed to avoid the repetition of costly mistakes and failures, this collection of lessons is accessible through the World Wide Web to authorized users. A unique aspect of the system is the automatic collection of metrics as the system is entered, providing insight into how effectively the system is being used by the space industry.

"Lessons Learned" from project management are currently produced on videotape by Goddard for Center, supplier, and Agencywide distribution. At the completion of a project, the principals are interviewed on the lessons they learned. This five year old program has produced 14 tapes with 5 more due for completion this year. The program is being expanded to include Compact Disk–Read Only (CD-ROM) disks, with the first one completed in early 1996.

Modern methods employed in process improvement include computer based concurrent engineering, a standardized approach to spacecraft computer architecture to enhance software reusability, and formal risk management. Computer-aided design, manufacturing, and engineering techniques are implemented to reduce development time, improve communication, and facilitate production. Three dimensional data modeling and visualization techniques have improved presentation of data and concepts.

5.2 Product and Service Production and Delivery

An integral part of Quality Management at Goddard is the constant effort to maintain and improve process performance. Critical processes are set out in detailed procedures which identify each step in the process to accomplish goals.

5.2a Evaluating and maintaining process performance

The Center is organized as nine directorates, which were established according to function, and have primary responsibility for process management (see figure 2 in Overview). Because of the multitude of different activities which take place at Goddard, Centerwide and within the various directorates, there are critical processes which are Centerwide, and others which are directoratewide, as demonstrated in figure 5.2. These processes contribute to the implementation of the Goddard key processes illustrated in figure 5.1, with the first two (Strategic Planning and Programmatic Work Planning) providing guidance to the critical mission development process.

Examples of Key Processes at Center and Directorate Levels

Examples of Centerwide critical processes include:

- Strategic Planning and Deployment
- Programmatic Work Planning - (New Business Committee)
- Budgeting Process Oversight and Institutional Planning - (Institutional Planning Committee)
- Monthly Status Review and Reporting Process
- Quality Management/Focus - (Quality Working Group, Goddard Contractors Association, Goddard Contractor Excellence Award Committee)
- Support Services such as Acquisition, Facilities Management, and Coordination of Information Resources

Examples of Directoratewide critical processes include:

- Engineering Directorate - H/W Development Process
- Mission Operations & Data Systems Directorate - S/W Quality Improvement Process - (Software Engineering Laboratory)
- Science Directorates Performance Benchmarking by External Peer Review

Figure 5.2 Key Processes at Center and Directorate Level

An important element of the Goddard Strategic Plan is the use of technology to maximize the value of Goddard products and processes. Simple in concept but very effective is the Technology Development Philosophy developed by the Engineering Directorate, shown in figure 5.3, which implements a philosophy of technology evolution and commonality. This is being expanded to become a Goddard Technology Development Process.

Engineering Directorate Technology Development Philosophy

(1) Understand future mission needs to guide technology focus

(2) Understand state of the art, future availability and required new developments

(3) Technology is evolved and proven through use of test-beds and initial application on low cost projects

(4) As proven, technology is applied to explorer and observatory class missions

(5) Where specific technologies hold promise for a variety of applications, a program to ensure the greatest commonality of components and cost sharing is instituted, to provide
   a. lowest possible program cost
   b. most expedient developmental effort

Figure 5.3 Engineering Directorate Technology Development Process

Goddard employs a system of program/ project reviews across the Center, many of which involve civil servants and contractors in partnering relationships where assessment is shared, and corrective action or process improvement activities are developed real time. An additional process in the personnel management area which looks at performance from a different perspective, is the use across the workforce of IDPs, which include the planning and evaluation of the work of each individual.

Examples of reviews and monitoring activities which are conducted by civil servants include those set up and coordinated by the Office of Flight Assurance, such as Performance Assurance Surveillance Plans and Systems Reviews. Performance Assurance Surveillance Plans identify specific areas that will be under surveillance, along with the planned frequency of surveillance and associated metrics that are required to support the surveillance plan. A Systems Review Schedule is established with each project, and becomes part of the project's master plan. In the Engineering Directorate, for example, peer level reviews are conducted at every level of software and hardware development to ensure high quality engineering by focusing highest levels of technical expertise at every stage of the development process. Reviews are covered in more detail below. Other reviews, which are conducted for people outside of the project, include science reviews by science committees, program management reviews by upper management, and non-advocacy reviews by NASA Headquarters teams using a peer review process. The various directorates also monitor performance in their respective areas, looking at cost, schedule, and technical performance data which is analyzed and factored into routine, periodic contractor performance evaluations. Senior Executive Leadership monitors significant problems and actions taken in response to them, from workgroups and projects across the directorates, through the weekly "Top Ten" list, as described in section 1.1a.

5.2b Process evaluation and improvement

Performance is reviewed on an ongoing basis to identify areas for improvements. All organizations at Goddard develop their own performance measurements to identify areas for improvement. Standard metrics are used including areas of measurement such as tracking of expenditures and labor hours on contracts, safety, mission success, and products produced from electronics to engineering. Projects develop unique measurement plans, tailored from guidelines provided by documents such as the Flight Projects Directorate Project Management Handbook.

The Hubble Space Telescope (HST) began a process improvement effort in 1993. Following an analysis of existing business processes, metrics were developed that measured output products as well as underlying processes. In the last three years, significant improvements have been made in the ability to provide data to a large and rapidly growing user community. Cost savings have been achieved by the Flight Operations Team, in part through staff reductions of 12% in science planning, 43% in science data processing, and 50% in mission operations. See section 6.2b for detailed improvements. Today, known as HST "VISION 2000," this endeavor has evolved into a highly organized set of teams that are examining processes at all levels of activity. Four key areas are being addressed; control center systems, mission planning and scheduling, science data processing, and flight software development. "VISION 2000" goals to be met by the year 2000 are: to become a technical leader in mission operations, to achieve 100% science observer satisfaction and increase the science user base, and to substantially reduce the cost of HST operation and maintainance.

A process analysis effort in the Flight Projects Directorate which had major impact was related to review of individual project cost overruns. An earlier NASA study showed that overruns are very likely if Phases A and B, preliminary analysis and definition respectively, are underfunded. Previously, during development Phases C and D, projects tended to strive for optimum performance,

often creating cost overruns. It was determined that it was much more cost effective to use integrated project teams and the peer review process at the mission design stage to establish requirements, including contingency descope plans to prepare for potential funding problems, and then hold rigidly to them. Annual budgets are considered to be essentially fixed, and work for the year is planned to optimize results within those budgets. These changes have virtually eliminated project cost overruns since 1991.

Similarly, process analysis within the LANDSAT project led to a reduction in the number of management positions/levels, increasing communication within the project organizations—both government and contractor. The establishment of integrated civil servant/contractor teams has reduced the duplication of analyses/studies, reduced government support levels by 25 % and contractor support by at least 10 %, substantially reduced formal paperwork as mentioned in section 5.1.b, and enabled them to meet very aggressive development schedules.

As part of various design and performance reviews mentioned earlier, data is compiled relative to Programmatic Concerns and Problem Failure Reports. Data bases are created for trend analysis and assessed on a project by project basis to control risk and contribute to mission success.

Benchmarking is practiced in many areas and ways across Goddard, from major external reviews such as the recent Federal Lab Review, to use of in-house project analyses to establish baselines or standards against which to more effectively measure performance of out-of-house projects, to the use of the Science Citation Index for benchmarking performance of science personnel.

The MIDEX program conducted a benchmarking study which involved several suppliers of small satellites, resulting in the establishment of operating guidelines for effective low-cost projects. Definitive metrics, tracking other Goddard/NASA/Industry team performance are also used by Goddard projects to quantitatively measure performance.

A different form of benchmarking occurs with the Research Labs which conduct external peer reviews, rating labs by direct comparison to first caliber academic programs. Data is selected to drive improvement of overall organization performance by comparison with nongovernmental organizations that do similar activities.

Illustrative examples of the use of alternative technology and/or innovative approaches are presented below, describing activities in several of the directorates.

Flight Projects Directorate

- Established PC-based information management system linked to an electronic library providing access to project technical, financial, and schedule data for integrated analysis and decision making.
- Enabled greatly enhanced capability of future space craft by the use of Capillary Pumped Loop systems, a groundbreaking new technology for heat transport in spacecraft, which was verified in the 1995 Space Shuttle experiment performance by Goddard.

Mission Operations & Data Systems Directorate

- The Software Engineering Laboratory, part of the Flight Dynamics Division, is a recognized leader in the development of the software production process. Their work has resulted in a greater understanding of this process, and dramatic savings to Goddard's flight projects. Significant benefits have been achieved through the reuse of previously generated software products, including code, processes, and development products (requirements). Notable process improvements include a 300% increase in reuse with a 75% increase in software reliability, and decreases of 55% in manpower and 38% in development time. Details are provided in section 6.1c.
- Developed a very significant application of alternative technology and approach, the Reusable Network Architecture for Interoperable Space Science, Analysis, Navigation, and Control Environments (RENAISSANCE), which was first implemented on the Advanced Composition Explorer (ACE) Project. RENAISSANCE is a new process for development and operation of Ground Data Systems (GDS) for flight mission support, driven by the goals of minimizing cost and maximizing customer satisfaction. Achievement of these goals is realized through the use of a standard set of capabilities which can be modified to meet specific user needs. The approach stresses the engineering of integrated systems, based upon workstation/LAN/file server technology and reusable hardware and software components called "building blocks." These building blocks are integrated with mission-specific capabilities to build the GDS for each individual mission. The building block approach is key to the reduction of develop ment costs and schedules.

The RENAISSANCE approach allows the integration of GDS functions which were previously provided via separate multi-mission facilities. With the Renaissance architecture, the GDS can be developed and operated by MO&DSD, or all or part of the GDS can be operated by the user at his facility. Flexibility in operation configuration allows both selection of a cost effective operations approach and the capability for customizing operations to user needs. Thus the focus is shifted from building and operating systems, to building systems with the option of operations as separate services.

Engineering Directorate

- Through innovative management approaches on such projects as Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX) and XTE, development times have been substantially shortened, and costs have been reduced. The practice of designing-to-cost, and zero tolerance for launch date delays have contributed to the reduction in spacecraft cost from $39.9M for the initial SMEX mission to $8.9M for the upcoming SMEX-Lite missions. The streamlined and horizontal management teams employed by the SMEX projects minimize group size, improve communication, and create a mission-wide perspective within each team member.
- Technology advances in the areas of hardware and software interface standardization have greatly simplified the integration and test process for the SMEX project. The fact that the SMEX project is multi-mission has greatly improved the effectiveness of the team. Lessons learned can be directly rolled from one mission to the next. Design savings which capitalize on prior missions exceed $3.2M just for the Transition Region and Coronal Explorer (TRACE) and Wide-field Infrared Explorer (WIRE) missions. Procurement efficiencies such as common buys and a running inventory have saved over $1.2M.

Earth Sciences Directorate

- The Space Data and Computing Division (SDCD) has been a leader in the strategic shift to networking and fast computation. In addition to super-computer facilities which SDCD brought to state-of-the-art and offered to researchers both within and outside of NASA, an innovative Scientific Visualization Studio (SVS) was assembled to provide services for the exploitation of new forms of electronic media —e.g., data visualization via 3-D graphics, and production of CD-ROM and video products. The SVS offers a unique array of technologies for understanding data about the Earth and space through color graphics, stereoscopy, and motion. These tools enable scientists to detect, identify, and analyze new phenomena and unsuspected aspects of existing phenomena, resulting in additional new scientific knowledge.

As discussed in several areas, customer input is of primary importance from establishment of requirements in early phases of design through production/fabrication, delivery, and operation. Customer feedback is obtained by real time interaction as well as surveys and evaluations.

A particularly interesting example of customer focus and the response to customer feedback is that practiced by Goddard's six highly-specialized science laboratories of the Earth and Space Science Directorates. The personnel and procedures of these laboratories are audited by visiting committees and reviewed by peers. The resultant findings are addressed by the complaint management process covered in section 7.0. This process has been of special benefit to the Mission To Planet Earth, as part of a comprehensive undertaking, where customer focus and response to concerns are a high priority.

5.3 Support Services

Goddard has five key functional areas that provide Centerwide support services. These services are: Financial, Human Resources, Acquisition, Information, and Base Operations. Each of the five service areas has key functional processes which are designed with the consumers of their respective services in mind and which provide direction and guidance to the actual performers of the service.

Key elements in the management of these Centerwide support services are the Institutional Planning Committee (IPC) and the Information Resources Oversight Committee (IROC). The primary function of the IPC, made up of senior directorate representatives, is to address the needs of Goddard institution as a whole and to use the strategic planning process to integrate mission and institu-

tional requirements. The goal of the IPC is to link integrated institutional planning with new business decisions upfront. Key support processes across the institution are systematically reviewed, monitored, measured, and continuously improved. The function of the IROC, which includes the Chief Information Officer and voting representatives from the Goddard directorates, is to manage Information Technology (IT), critical to the accomplishment of NASA programs and missions. The specific task of the IROC is to coordinate activities across programs and organizations by defining strategies, policies and standards at the Center level.

5.3a How key support services are designed

Requirements for support services are driven by external forces, as well as internal forces and customers. Some examples of external forces are changes in federal regulations and codes due to initiatives such as "acquisition streamlining," "reinventing government," the National Performance Review, and more stringent building safety codes. Internal customers include NASA scientists and engineers, who require training, facility and laboratory space, timely procurement support; on-site support contractors who may require government equipment and logistic support; and other sister support organizations who interface with each other. The contractor community also influences support processes through recommendations made through the Goddard Contractor Association.

In an era of shrinking budgets and shifting programmatic emphasis, our challenge is to find new and more effective ways to define support services while including customer requirements and maintaining product and process integrity.

Specific examples of process design change resulting from customer input include addition of such conveniences as implementation of the use of credit cards for small purchases by designated office support personnel across the Center, and establishment of a "One Stop Shop Small Packages Office" to expedite shipping and handling of small individual packages. The procurement community has also streamlined a number of procedures including contract terminations, Small Business Innovative Research (SBIR) Phases I and II, and contract change orders.

A very successful major process change was the development of an automated Small Purchase System (SPS) which has greatly improved the effectiveness of the small purchase process, improving the efficiency of many of the tasks associated with the end-to-end process. SPS has reduced the average procurement leadtime by 75%, from 42 days to less than 11. The automated interface also saves manpower and prevents errors as it eliminates the need for manually checking or rekeying data during the commitment transaction.

5.3b Maintaining key support service process performance

Processes are maintained and tracked through periodic performance self-evaluations by process owners - including self-assessments at least once every three years by all Goddard functional managers, through customer surveys and rating sheets, electronic WWW feedback bulletin boards, standing process teams, participation of directorate personnel on Performance Evaluation Boards (PEBs) and Source Evaluation Boards (SEBs), and through informal open communication channels. The Base Operations organization, for example, leaves a rating sheet with each customer that is serviced at the conclusion of every job. Base Operations also routinely gathers benchmark data from other government agencies and private industry. For example, Goddard has many of the same characteristics and constraints as Dupont, 3M, and Disney in terms of hours of operation, numbers of customers, and availability, cleanliness, safety, and maintainability requirements. Due to this similarity, these companies were used as benchmarks for many of the base operations processes.

Over the last year and a half, the finance organization, in collaboration with other support organizations, completed a thorough review of all finance processes and interfacing processes in preparation for the transition to a new Integrated Financial Management System (IFMS). All systems, flows, and metrics were thoroughly reviewed for applicability and improvement. An Request for Proposal (RFP) was recently released to select a commercial-off-the-shelf product for IFMS implementation. For this initiative, as well as many others, cross-functional working groups were spun-off to investigate processes and requirements, and to make recommendations to the IFMS team. NASA's Ames and Marshall Centers were used as benchmarks during this activity.

Each support organization tracks and reports monthly on established metrics for its processes. The acquisition organization, for example, tracks such metrics as cycle time, percentage of small business/small disadvantaged business

contract awards, small purchase expenditures and savings, change order processing, workload balance, etc. Results from these metrics are compared to benchmark data to determine if problems exist or improvements are needed.

5.3c Evaluation and improvement of key support service processes

The key to effective and efficient processes is a thorough understanding of the processes by both the process users and the customers. For this reason, for example, the Management Operations Directorate (MOD), which includes Base Operations, Acquisition, Logistics, and Information, has developed a Mission Enhancement and Team Building Seminar (METS) which is given to internal directorate personnel as well as support contractors and customers to familiarize the community with the MOD processes and services and to receive feedback from the attendees. When an area for improvement is identified, focus groups and process action teams are formed to tackle the problem. The IPC, mentioned previously, looks at issues across the center and identifies cross-functional groups to work specialized process issues. Pilot projects, such as automated small purchasing, are spun-off to test new ideas.

Innovative partnering agreements have been negotiated to improve processes involving government/contractor relations. An outstanding specific example is the Facilities Management Division construction partnering program which began in 1992. Initial benefits from improved communications at all levels of project implementation, including the higher levels of management within the partner firms, became immediately obvious. Three common themes of these agreements have been minimizing cost and schedule growth and preventing litigation. Data shows that partnering efforts have reduced cost growth average from 11.4 to 6.6%, schedule growth from 30.2 to 17.5 %, and while seven claims were submitted on non-partnered contracts in 1991 and 1992, no partnered contract to date has received a claim. Based on an average Construction of Facilities budget of about $29 million/year for the last three years, it is estimated that annual savings have been $1.4 million/year in direct facility construction cost. This does not include the man-hours saved due to avoided litigation or savings to customers in earlier delivery of facilities.

Cross-functional teams have been formed to address common process improvements across the entire center, such as the "cost-per-copy" single source initiative, which has significantly reduced copier associated problems and provided an estimated first year cost savings of $591,000. In addition, there are several examples today within Goddard whereby process teams have been so successful in implementing improvements within Goddard that other government agencies and contractor companies have asked to use the process. Examples of this are the Automated Library and the Scientific and Engineering Workstation Procurement process (SEWP). Library automation provides electronic access to library resources, the first application of its kind involving a WWW home page for a data base. The data base is unique in that it is created using commercially available data from the Institute for Scientific Information (ISI) which is manipulated for use on the WWW. Key benefits to users include ease of use and availability of many search options with good results and returns. The SEWP process has provided substantial reduction in procurement lead-times, from typical 4 to 6 *months* to 4 to 6 *weeks* including shipping time, at reduced cost, and with provision of computer support services to users.

5.4 Management of Supplier Performance

Goddard manages supplier performance through effective processes tailored to the size and type of goods and services to be provided. The process of managing performance is an evolutionary process, focused on continual process improvement in a changing environment through effective partnerships with our suppliers, including joint development of goals and metrics to optimize product/service design and maintain performance.

5.4a Summary of organization's requirements and how they are communicated to suppliers

Our suppliers are selected via a competitive proposal submission process. For large contracts and purchases, Goddard develops a RFP containing the requirements, specifications, and performance levels expected for that work. Announcements of RFPs and draft RFPs are circulated via the Goddard procurements Internet home page and through Commerce Business Daily articles. Key requirements for each procurement, large or small, are that the proposing entity fulfill all of the specifications laid out in the RFP, that it provide the most cost-effective solution, and that it work within all applicable laws and regulations to complete the contracted service.

All submissions to the RFP are evaluated and scored against the RFP specifications by an SEB or streamlined process. Small and mid-range procurements are handled by buyers with expert knowledge of the potential market vendors for each product. In either case, a best value determination is made. Winners and losers are notified of their status; losers are debriefed by Goddard representatives, providing them with valuable information on how they may improve any subsequent submissions.

Goddard determines that the supplier has met the requirements of the procurement by means ranging from receiving acceptance of a product to continual monitoring of long term services or complex systems. Depending upon the type of contract award, quarterly, semi-annual, or annual contract reviews are conducted by Goddard officials serving on a PEB. The review results are presented to the supplier. In addition, feedback may be given on a day-to-day basis to suppliers and other personnel housed on site.

Through effective communication of requirements, the supplier knows the expected performance levels that must be met to earn high percentages of the available fee. Examples of major procurement partnerships include those with AlliedSignal,Computer Sciences Corporation (CSC), McDonnell Douglas, and Unisys, who provide support services to their respective Goddard directorates, and Raytheon who operates the Logistics Support Depot, addressing the key role of incorporating Integrated Logistics Support (ILS) in the design and delivery process of meeting customer requirements.

Goddard relies upon establishment of face-to-face interaction with suppliers to monitor performance and provide supplier feedback. This is accomplished by various means, including housing of contractor personnel with process organizations onsite at Goddard, and establishing NASA resident offices in the facilities of suppliers that are remote from Goddard. In the case of remote suppliers, these resident offices can be staffed on an as-needed basis with technical and management experts, to support contractor efforts to improve performance.

5.4b Evaluation and improvement of management of supplier relationship and performance

Goddard evaluates its management of supplier performance by feedback from its suppliers, and customers of the goods or services. This feedback is part of the open communication between Goddard and its suppliers that allows for real time resolution of performance issues. Goddard has actively sought to create partnerships to improve the supplier's ability to meet requirements as discussed in section 5.4a. The resulting relationship between Goddard and the GCA has yielded jointly sponsored CI seminars, which share the best practices and lessons learned to improve performance. This has been a very good vehicle for current and potential suppliers to gain knowledge that will improve their abilities to meet Goddard's requirements. A typical example of a specific improvement resulting from the combined work of Goddard and the GCA, was the development of a broad series of standardized position descriptions which can be easily tailored to meet the needs of a specific procurement.

Several improvements have been made to the procurement process to better manage the performance of Goddard's suppliers. Electronic contracting posts future procurement opportunities, provides a means of feedback to procurement, and provides useful information to current and potential suppliers. As an example, part of cost performance for a supplier is the timely and accurate delivery of the Contract Cost Status Report NF533. A tutorial on the NF533 was developed and can be downloaded from the Procurement home page.

The reorganization of procurement at Goddard has included development of teams focused on improving the procurement process. This has included the Customer Value Process Action Team and the Small Purchases Review Team. Procurement has also used contract vehicles to allow for more incentives to suppliers to meet requirements. Typical prime contracts use the award fee to reward positive performance and to penalize when performance falls short of requirements.

Another contract vehicle used is the Performance Based Contract (PBC). Tracking and Data Relay Satellite–(TDRS) H-I-J, and the consolidated Allied Signal and CSC contracts for the MO&DSD are examples of PBC. In PBC, performance metrics are tied to fee earned or lost by the supplier. This method allows for opportunity to gain fee and risk of losing fee, two factors which are powerful incentives to the supplier.

The PBC also provides a low cost means of verification of performance. Since metrics are developed at the onset of the project, verification is simply the result of these metrics on a timely basis. Partnerships allow for real time verification of performance, which also reduces the cost.

6.1 Product and Service Quality Results

Goddard's key products–new science and new technology– are supported by three key product lines; **new scientific knowledge**, **new technology**, and **new data**. These are tightly coupled with NASA's strategic enterprises, (Mission to Planet Earth, Space Science, and Space Technology.) Because Goddard is primarily a scientific research institution, its product lines are derived either directly from its scientific research, or are produced to enable that research. These product lines are wide ranging including science products (including peer-reviewed publications), scientific data (data obtained from any Goddard mission or field campaign), and technology-based tools (including new instruments, spacecraft, launch vehicles, and software).

It should be noted here and throughout sections 6 and 7 that the ultimate value of a science research data product cannot always be directly measured. Oftentimes the product, combined with the immeasurable contribution of a scientist or user, produces a breakthrough science result or educational application. These data and examples are linked to the 1989 and 1991 Strategic Plans, not the new 1996 Strategic Plan described in section 3. The 1996 plan is our future direction, and will not map one-for-one to the results described below.

6.1a Product and service quality—science knowledge products

Key indicators of the quality of science knowledge products include the number of publications (especially in the peer reviewed literature), the significance of those results in terms of their respective disciplines, and the usage of these publications by others. The total output of peer reviewed publications by Goddard civil service personnel has been and remains high with a steady upward increase for the last 6 years (figure 6.1).

Within the world scientific community, peer review is the primary mechanism used to establish and maintain the quality of scientific research and publications. This mechanism has proven over the years to be highly effective at maintaining the quality (accuracy and significance) of research publications. The emphasis within Goddard's science laboratories on publishing *all* results in the peer reviewed literature serves to place Goddard research at the same level of scrutiny as research performed at any academic institution in the world.

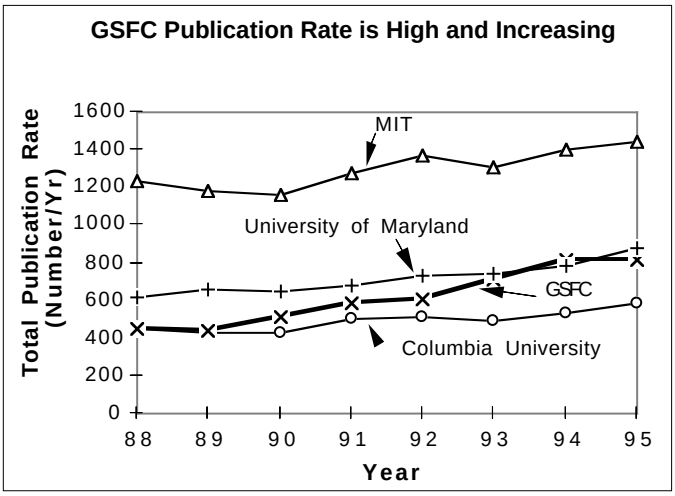


Figure 6.1

The sheer number of publications by Goddard scientists and the yearly rate of those publications by Goddard as a whole (616 per year) is a reflection of the quality of science performed at Goddard since only the best research papers pass peer review. These rates for the institution as a whole are comparable to or exceed those of the most prestigious scientific research facilities in the U.S. which are active in the same fields as Goddard (see benchmarks in figure 6.1).

Lastly, the utilization of Goddard research by others is a key measure of its quality and impact since significant research results are used by other scientists in the development and publication of their research. We use two metrics to indicate the utilization of Goddard research and how it compares to other research institutions—1) the percentage of Goddard publications that are cited and 2) an index developed by ISI that compares the citation rate of a publication against that of other comparable publications. The first metric (figure 6.2) shows that a very high percentage of Goddard publications have been cited three years or more after publication (91%) and that this rate is equivalent to its academic counterparts–Columbia Universtity (91%), Massachusetts Institute of Technology (89%), and University of Maryland (88%). The second metric, citation rates of publications by Goddard authors compared to similar publications by non-Goddard authors have a greater citation rate than the norm (figure 6.3). Over the last six years, the actual rate has been 25% higher than the expected rate of non-Goddard authors. These data demonstrate that on the whole, Goddard science products are equivalent to the best in the world.

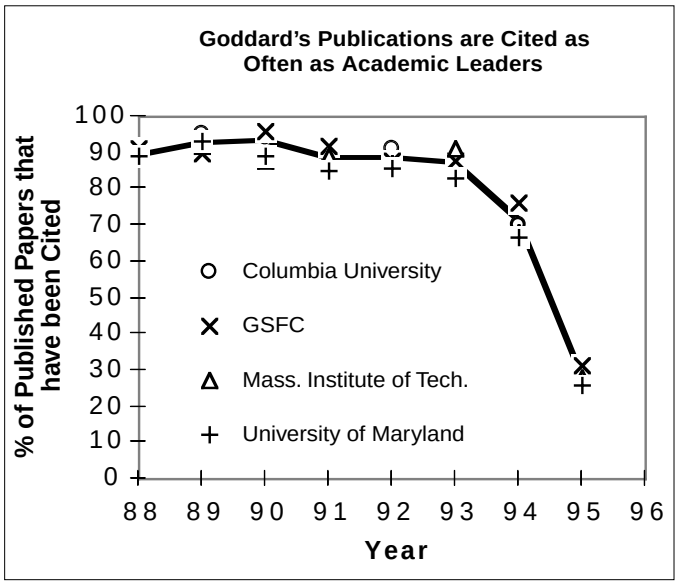


Figure 6.2

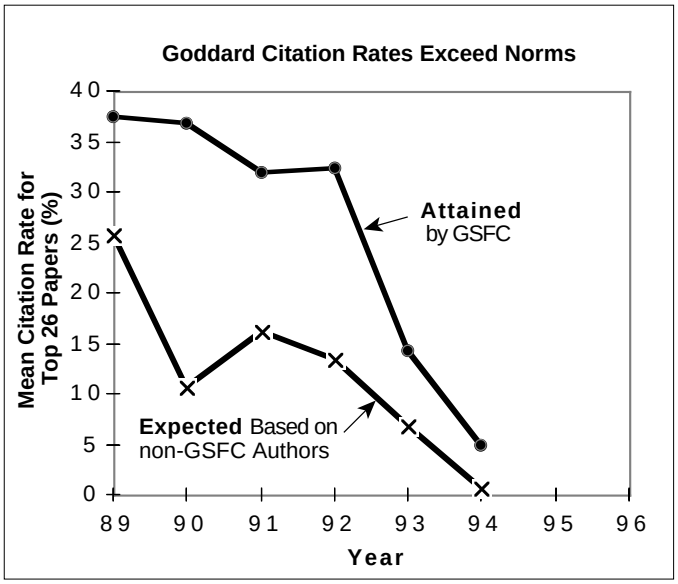


Figure 6.3

6.1b Product and service quality—science data products

Science data, the second product in Goddard's product suite, is a primary product of Goddard's science missions and field campaigns. These data are made available to the national and international science and educational communities for research and instruction.

There is a very high diversity and large amount of scientific data available from Goddard's space science and Earth science archives and missions (orbital and suborbital flight projects, field experiments, and models). These data cover the land, atmosphere and oceans of Earth. In the space sciences, they cover our solar system, galaxy, and universe. The diversity of these data is reflected in the number of parameters contained in these data and the number of scientific disciplines which they represent (figure 6.4). The diversity and number of these science parameters and disciplines has increased greatly over the last six years. In the Earth sciences there was no coordinated method of providing Earth science data to the scientific and educational community before 1991/1992. At that time a new organization was created to consolidate many of the Earth science data providers at Goddard into a single, coordinated data provider. This new organization took 12 to 18 months to begin servicing "customers" and hence explains the lack of data for the Earth sciences before that date. Before then some of the data was provided by the current space science provider and is reflected in those metrics, and the rest was provided by several other focused prototype/pilot and operational "project" services.

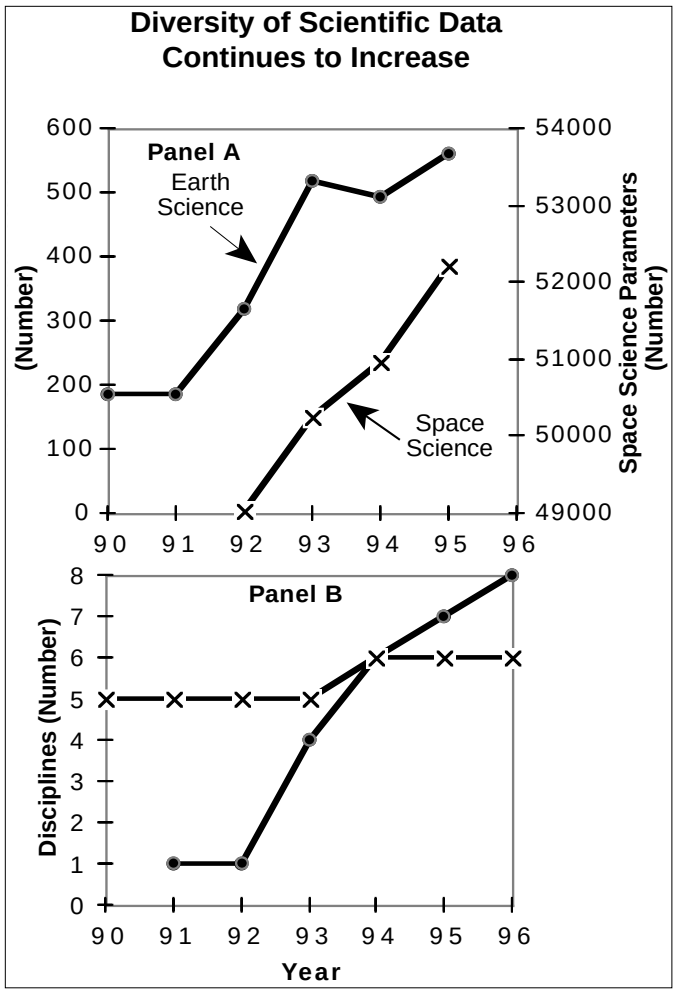


Figure 6.4

Another measure of science data quality is the number of customers that use these data. The scientific and educational communities have the choice to use or not use Goddard's data products. Hence, one measure of quality is the simple choice by these groups to use these data. The increase in the number of clients (figure 6.5) and the number of orders (figure 6.6) reflects this quality. Goddard's data providers have undertaken a variety of activities to remove barriers to the usage of Goddard's science data that have enhanced these statistics.

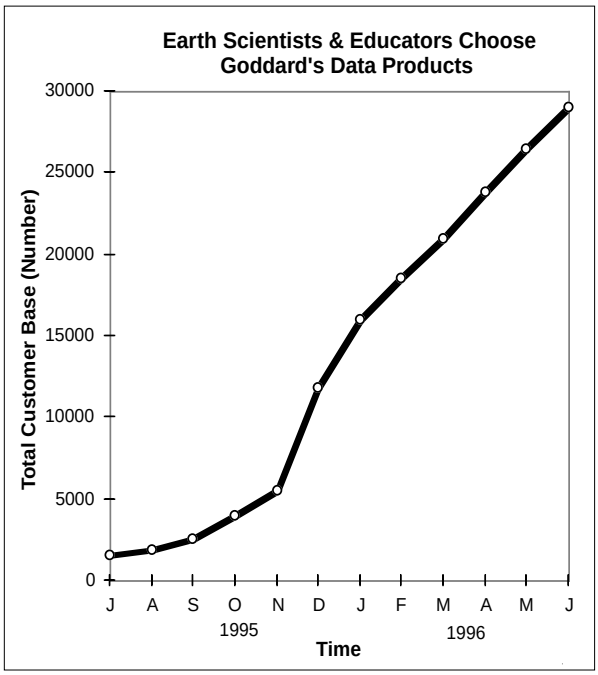


Figure 6.5

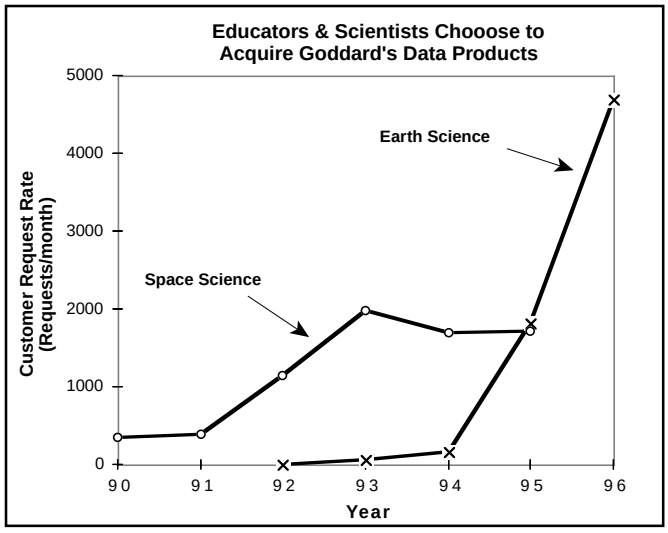


Figure 6.6

product access is targeted to meet the needs of different sectors of the customer base. For example, few grade or high school educators, or educators in 2- and 4-year teaching colleges, have ready access to electronic networks, to sophisticated computers or peripherals (Unix workstations, 8 and 4 mm tape drives, etc.), or to computer professionals. As a result, data on compact disks (CDs) are extremely popular for these audiences, as are hardcopy material such as lithographs.

The speed of data and information access has also greatly increased over the last 5 years as more data and information has been migrated from the off-line, single-copy tape rack to more readily available, cheaper to de-

Another measure of data and service delivery quality is the ease and speed of acquisition and use of Goddard's data by the customer. During the last 6 years, the number and diversity of ordering mechanisms has increased. There is now an ordering or delivery mechanism for everyone (figure 6.7). Scientists, educators and the general public can now obtain NASA data and information using nine different mechanisms ranging from WWW ordering to handwritten letters. In a similar way the delivery mechanisms are extremely broad, ranging from electronic to paper. In addition, data is often made available via more than one of these distribution avenues so that products and

Method	Ordering Method	Date First Offered	Distribution Method	Date First Offered
Electronic Mail	✓	Before 1989	✓	Before 1989
World Wide Web	✓	1993	✓	1993
Anonymous	✓	1992	✓	1992
On-line Menus	✓	Before 1989		
FAX	✓	1995		
Telephone	✓	Before 1989		
Surface Mail	✓	Before 1989		
Conferences	✓	Before 1989		
Walk-ins	✓	Before 1989		
FTP Stagged			✓	1993
Tape				
9-track			✓	Before 1989
8 mm			✓	1992
4 mm			✓	1993
3480			✓	1993
CD-ROM			✓	Before 1989
Floppy Disk			✓	Before 1989
Film			✓	Before 1989
Photos			✓	Before 1989
Paper			✓	Before 1989

Figure 6.7 Variety of Data Ordering and Delivery Mechanisms Expands

liver media (i.e., on-line in robotic mass storage units or on spinning disk, or on CDs which have a long shelf-life and are inexpensive to mass produce). Today only rarely used data are held off-line in a single copy mode. Hence, the overall time for a customer to receive data has decreased steadily over the last few years (figure 6.8). This decrease is directly linked to this change in delivery methods.

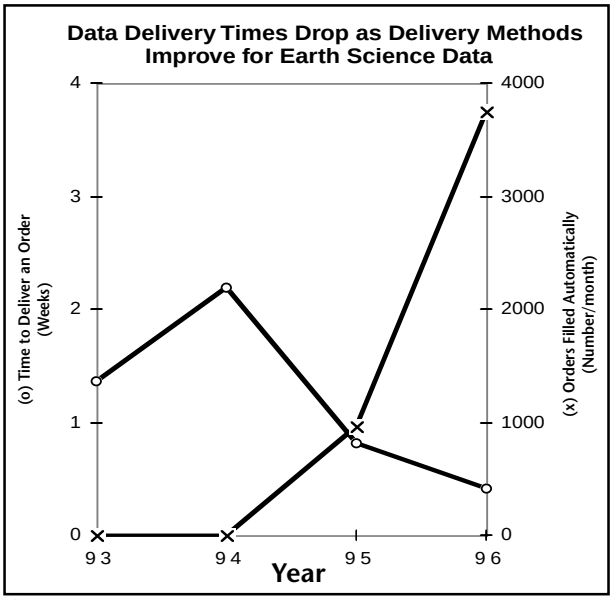


Figure 6.8

Another measure of quality is the resources saved by our customers because the data was packaged (targeted) for their use. The trend is toward standardization of documentation and toward very simple standardized data structures that can be used by anyone and do not become obsolete in 5 years. By simplifying the data and documentation in this way Goddard makes the data useful to a larger sector of the American science and education communities and makes more effective utilization of their resources. In one survey, the users of such a data product stated that the product saved each of them from 6 to 12 man months of effort and made research or educational applications possible that otherwise would not have been undertaken.

6.1c Product and service quality—technology products

Goddard has a very diverse suite of technological products which it produces in-house or contracts out-of-house for development. They range from satellite instruments, spacecraft and launch vehicles, to sophisticated software for orbit and telemetry of spacecraft, to super-computers. In all cases, the quality of these products is extremely high, as is the customer satisfaction with these products (see section 7).

In the area of orbiting spacecraft and launch vehicles, Goddard procures and manages the launches for the government of all Delta and (for NASA) all Pegasus expendable launch vehicles. Since the initiation of the Space Communications Act in 1988, Goddard has launched 26 spacecraft with zero failures. During the same period, commercial organizations have launched 44 payloads with 6 failures. Over the entire period, the average failure rate is 13% for commercial providers and zero for Goddard. Since the cost of a spacecraft and its instrument payload is a significant financial asset (anywhere from $75 to $427 million) the loss of a payload due to launch failure can have catastrophic impact on customer satisfaction.

In addition to launches of spacecraft and instruments intended for Earth orbit, Goddard has a highly effective suborbital launch program of rockets and balloons. This program launches instruments that collect data for basic scientific research, and instruments that are prototypes for instruments slated for the more expensive orbital launch missions. In this way, the rocket program serves as a proving ground for new technology.

The launch history of this program is impressive. Since 1988 Goddard has launched over 225 rockets (about 30/year) with a failure rate of less than 3%, from a product line that is designed, built, and funded to accept a failure rate of 15%. This compares to the commercial suborbital launch failure rate of 11% for the same period. In addition to this high launch success rate, the payloads carried aloft have a success rate of greater than 86%. Again, this is significant since many payloads use prototype technology and hence have a high expectation of failure. Finally, the rocket program has as a basic capability to rapidly respond to unexpected events. An example is the building and launch of a rocket within 44 days to observe Comet Austin in 1990.

The satellites and instruments which Goddard builds, launches, or maintains in support of its strategic areas of space and Earth science, range in size and complexity from very large, very complex instruments such as the HST, to the very small explorers such as Fast Auroral Snapshot Explorer (FAST).

Science instruments aboard spacecraft have improved in quality over the last 15 years. The HST and Explorer spacecraft are good examples, (see section 6.2b). Using

an example from the Explorers line of spacecraft, instruments that measure far ultraviolet wavelengths have improved in resolution by 50%, bandwidth has improved by 125%, data storage from zero to a gigabyte (10^9 bytes) and detector sensitivity has improved by 5 orders of magnitude all at significant cost savings (see section 6.2 below).

One of the other quality, performance improvements that is currently being implemented is a shift from the effort placed in the spacecraft to the scientific instruments. Today a significantly greater portion of overall mission resources (i.e., dollars, power, space, development time) is being placed in the instrument–the portion of the mission which yields the scientific discoveries. Historically, (before 1991), instrument costs received 35% of the total flight segment budget, today that number has risen to 55% for the two MIDEX missions slated for launch in 1997 and 1998.

Overall, the reliability, and hence quality, of Goddard spacecraft is high. Since 1980, the actual useful life of spacecraft built and launched by Goddard averages 5.5 years versus the average design life of 2.5 years. NASA's strategic science enterprises are able to collect twice as much data and hence be twice as productive for half the cost (see section 6.2 for cost details). Moreover, for instruments that are designed to be launched in a series with multiple satellites collecting data at one time, this means that fewer satellites are needed. An excellent example are the Polar Operational Environmental Satellites (POES) and associated instruments which Goddard builds and launches in partnership with NOAA. These spacecraft provides much of the data used for weather forecasting around the world. This spacecraft series is designed to last 18 to 24 months with a 6 month overlap between old and new missions. At this point in the lifetime of the project, NOAA would be needing the 16th satellite. Because of the high reliability of the spacecraft, Goddard is just now building the 12th in the series, meeting 100% of NOAA's data needs with 25% fewer satellites.

Another technology area where Goddard has shown major improvements in the last 5-10 years has been in software development. Goddard annually spends $200–$300M on software development. Improvements in the software development processes have greatly improved the quality of software, decreased the software development time, decreased the software maintenance effort and have thereby reduced costs (see section 6.2c for details).

One prime example is the software development to support spaceflight dynamics, telemetry simulation, and attitude ground system support. The error rate in "code" has dropped by 75% since 1977 (from an average of 4.5 errors/1000 lines of code to 1.1) and the range of variation has decreased by nearly 50% because of process improvement activities.

Another factor which reflects software quality and cost is the reuse rate of existing code. The MO&DSD has been able to demonstrate an overall reuse rate of 79% since 1977, compared to 18% for earlier projects.

The final technology product which has shown significant improvement in quality over the last 7 years has been the development and availability of super-computer and parallel computing technology. In 1977, Goddard led the way in NASA with the development of a prototype parallel computer. Over time the development of that technology matured and was picked-up by the commercial sector. Today the super-computing facility at Goddard has established a partnership with industry through the "Mass Storage and Super-Computing Quality Partnership" which enables the infusion of new technologies into Goddard's super-computing environment and encourages vendors to "stretch" their technology. This partnership has resulted in a significant increase in performance of the super-computer facility at Goddard (figure 6.9) with a significant reduction in cost (section 6.2).

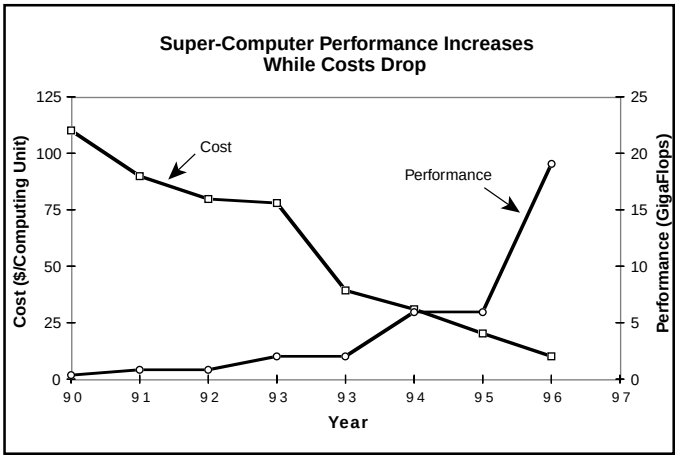


Figure 6.9

6.2 Operational and Financial Results

Goddard's scientists have increased their productivity as indicated by a 63% increase in publication rate since 1989. The data providers are servicing 19 times more customers with smaller budgets and Goddard's technology providers have become more effective at managing their budgets.

6.2a Operational and financial results—knowledge products

In conjuction with the extremely high quality of Goddard's knowledge based products, as shown in the previous section, the productivity of Goddard scientists is also very high, considering that scientific research results come in "fits and starts." An individual may labor for 2 or 3 years on a problem, publishing little, and then publish several papers in one year as the research culminates. In addition, Goddard scientific productivity has maintained a constant and steady cost effectiveness over this time period (figure 6.10). Increases in research budgets beginning in FY91 are largely due to the initiation of the Earth Observing System (EOS) project for which the first data, and hence research results, will not be available until at least 1998. Thus, Goddard scientists have actually been able to produce more with less since this money has gone primarily into mission development and *not* into research.

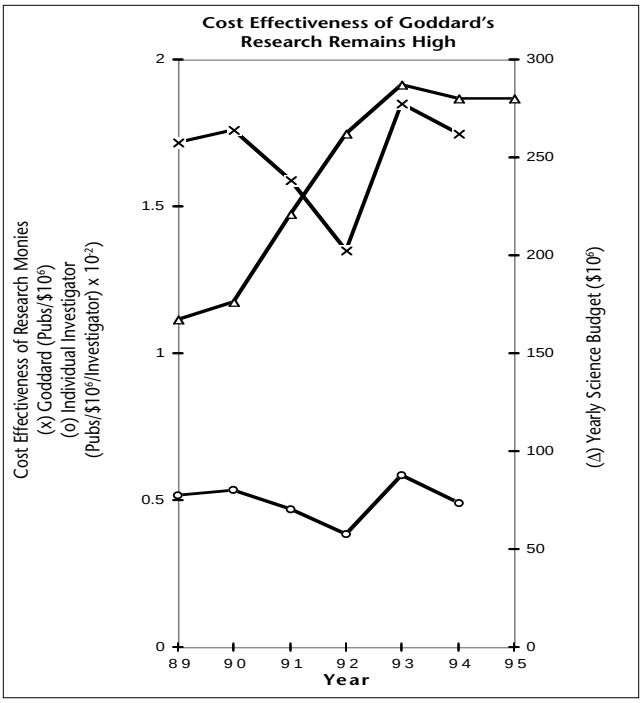


Figure 6.10

6.2b Operational and financial results—science data

The collection, processing, and distribution of scientific data has become significantly more efficient and cost effective. From 1988 through 1994, the number of satellites supported by the space Tracking and Data Relay Satellite System (TDRSS) grew from six to nine simultaneously, while the actual minutes of data delivery per month increased 5 fold from 21,000 minutes to over 130,000 minutes.

During the same period, the operational spaceborne instrument collection systems have also become more efficient. The HST is a good example. Since July of 1990, the overall trend in efficiency of data collection has increased from 25% to 55%. This was a direct result of the Project's decision to conduct formal training for its members in Continuous Process Improvement classes, and applying the training to this "Orbit Packing" problem. It is all the more spectacular when compared to the predicted 35% efficiency of the HST when it was built and the theoretical limit for the data collection efficiency (60%). The HST's peak activity is approaching that limit. Sustained utilization was over 55% in July 1996 and is still heading upwards. This significantly higher than predicted rate has enabled the HST to achieve the number of exposures (i.e., images of our universe) in 6 years that was originally planned for 10 years.

The overall data processing and delivery efficiencies have also increased during the last 5 years. Again using HST as an example, in 1993 it took 19 weeks for scientists to receive data from the HST (from the initial data collection proposal to having the data in their hands). By June 1996 it took only 7 weeks, a 66% reduction in delivery time. These and other improvements in performance of the HST (figure 6.11). were accomplished by improvements in processes and automation. In fact, staffing decreased 43% while performance was increasing.

Similar improvement has occurred in other Goddard space and Earth science data processing and archive centers. The Goddard Distributed Active Archive Center (DAAC) for example now has a client base of over 30,000 while in July 1995, it was less than 1,500 (figure 6.5). This 20-fold increase in client base was achieved with constant staffing. In addition, the cost per order filled has decreased significantly (up to 99%) over the last several years as systems have become more automated, and more data and information are provided in an on-line, unattended mode (figure 6.12).

Hubble Space Telescope Improves Performance*

METRIC	Feb-93	Aug-94	Jun-96
Observing Hours/Year (5300 max/yr)	2400	3500	4815
Lead Time for Target of Opportunity	2 wks	4 days	24 hours
Customer Cycle Time (from Proposal to Data Delivery)	19 wks	7 wks	7 wks
Customer Returns (Schedule Rework)	12/month	4-8/month	1/month
Backlog of Customer Returns	4	2-3	2
Number of Operations Problems (Downtime)	10/wk	5-6/wk	5/wk
Time to Resolve Operations Problems	13 wks	13 wks	5 wks
Backlog of Operations Problems	350	200	140

** Results achieved while staffing dropped: Spacecraft operations by 50%, Science planning by 12% and Data processing by 43%.*

Figure 6.11

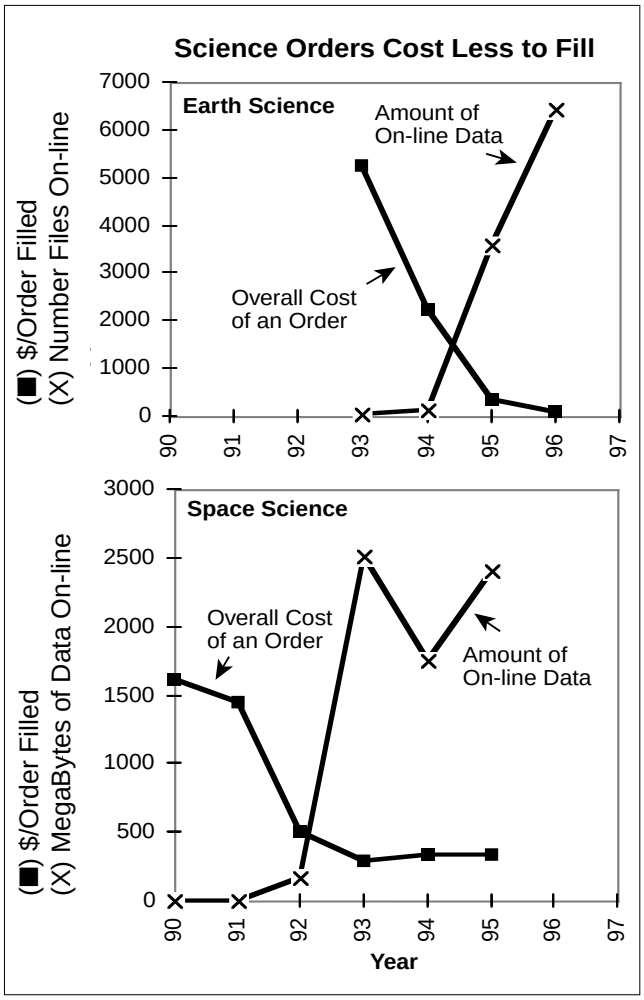


Figure 6.12

6.2c Operational financial results—technology products

The cost effectiveness of Goddard's technology products has improved over the last several years. They have shown a decrease in production or operational cycle times and other measures related to meeting or reducing delivery schedules.

In the area of spacecraft and instruments, Goddard has been building larger, more complex spacecraft and instruments over the last 30 years as reflected in the weight of the instruments (38 pounds average for 1964-69, versus 831 pounds for 1990-93). These more capable systems have taken longer to build (38 months in '64-69, versus 88 months in '90-93) and have been more expensive ($7M versus $49M). However, when the time to build and construction costs are adjusted for inflation and the complexity of the instrument and spacecraft (weight is used as a surrogate for spacecraft and instrument complexity), both the time and cost to build an instrument, and the time and cost for the entire prelaunch period have decreased significantly (figure 6.13). For example, the time to build an instrument of equal complexity has decreased 79% since the 1970s, and the cost to build (in 1995 dollars) has dropped 33%.

In addition, in the last few years Goddard has shown an improvement in its ability to keep instrument and spacecraft project costs within or under budget. For example, the spacecraft in the MIDEX series which were launched before 1993 overran their cost projections by

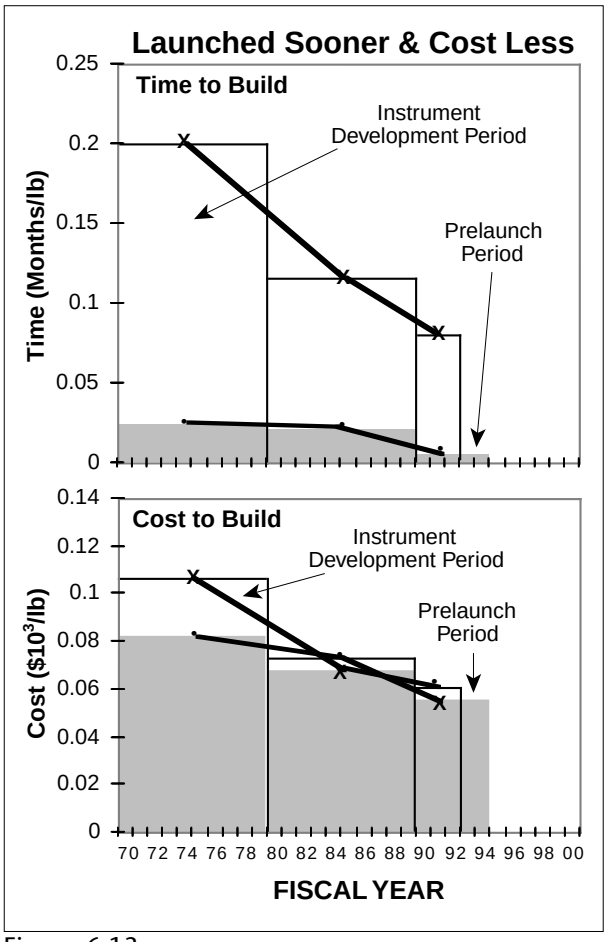


Figure 6.13

about 12%. XTE, however, which launched in December 1995 had a cost *underrun* of 16%, and ACE, which is slated for launch in August 1997, is currently running at 11% under budget. Initial budgets were considered ambitious by government and industry standards, and utilized assumptions of process improvement. This data indicates the process improvement assumptions were exceeded.

In addition to these improvements in the ability to contain project costs, the ability to meet launch schedules has improved. Again, in the same product line for Extreme Ultraviolet Explorer (EUVE) there was a launch schedule slippage of 10 months (launched in August 1991), while XTE launched 4 months *early* even after experiencing launch vehicle delays. ACE is currently projected to also launch 4 months early (August 1997).

The MIDEX program is also a good example of overall reduction in cost-of-flight segment over historical Explorers missions. Two current MIDEX missions, Microwave Anisotropy Probe (MAP) and Imager for Magnetopause-to-Aurora Global Exploration (IMAGE), represent a 10% mission cost reduction over historical Explorer missions. In addition, the proportion of the cost spent on the spacecraft is down by 20% thereby freeing resources for the instrument–resources which directly benefit the scientific productivity of the mission.

The suborbital rocket program has also maintained a good cost performance ratio. Since 1987, the overall cost per launch has remained around $1.1M.

Another of Goddard's technology products is software. The operational and financial performance features of Goddard's software development activities have in some areas seen a reduction in software development costs that are tied directly to improvements in the software development process. The flight dynamics software described above (section 6.1c) saw a 55% reduction in manpower and cost when compared to the baseline period of 1985-1989. In addition, the average cost to develop a line of code decreased by 10% based on 78 software projects covering 24 missions. Moreover, the range of variation narrowed indicating that costs have become more predicable.

The last technology product to be discussed is Goddard's super-computer facilities. The operational performance of these facilities has improved greatly since 1990. The cost of a computing unit has decreased steadily over this period (figure 6.9). At the same time there has been a steep increase in performance. The cost of a computing unit has dropped by 73% since 1990, to a low of $20 in 1995. Over this same period the performance to cost ratio (GigaFlops/$/computing unit) has increased significantly (about 1200 times) (figure 6-14).

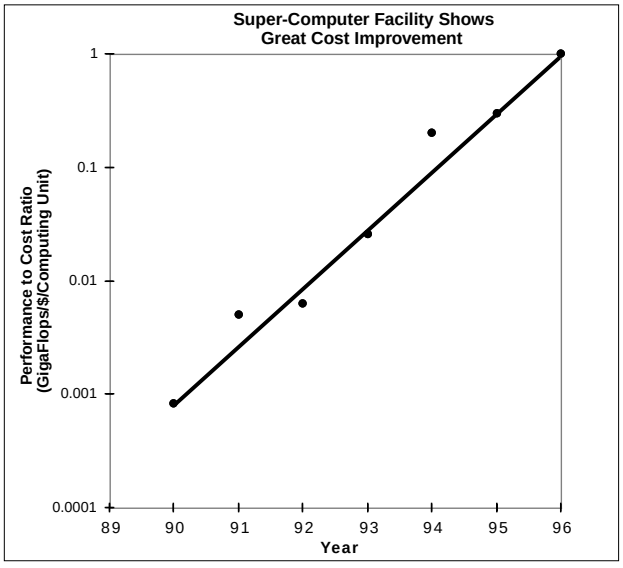


Figure 6.14

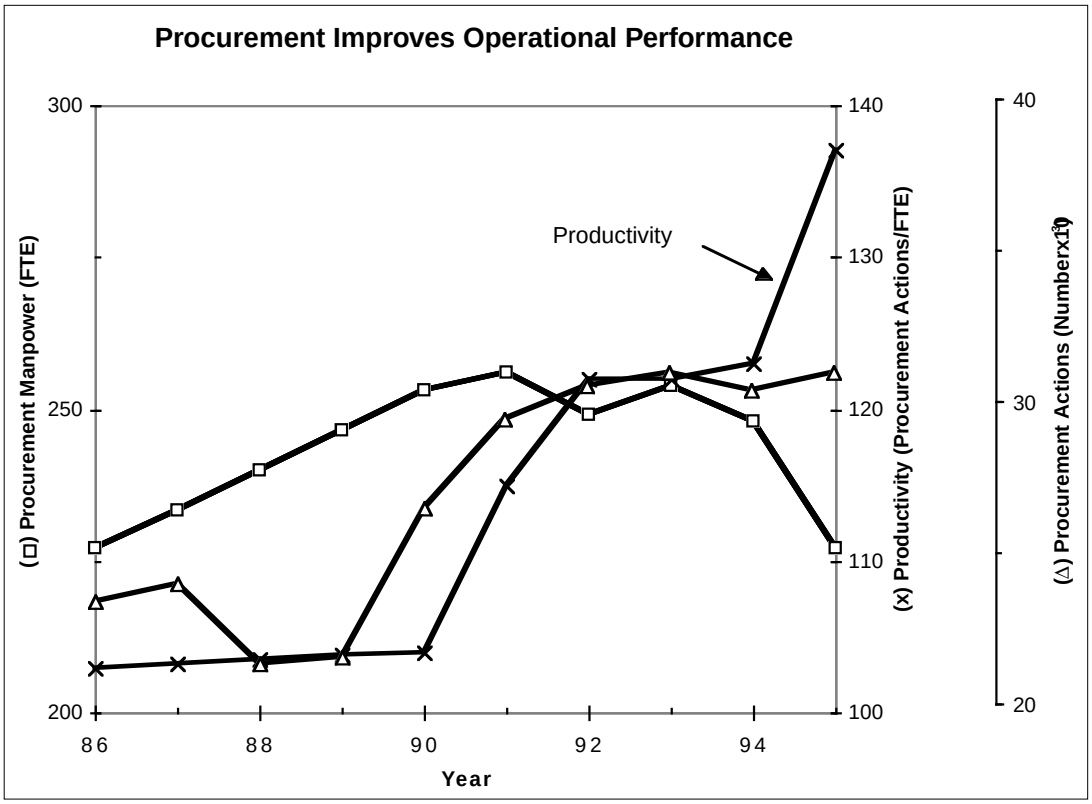


Figure 6.15

This streamlined process serves as a model for the Agency and is a candidate for Agency-wide implementation.

Cycle time for open-ended contract actions has decreased significantly over the last 5 years. In addition, the number of these actions which exceed standard lead time (180 days) to process has also dropped (26 in FY93 vs. 18 in FY95). This reflects an increase in productivity since the manpower to process these changes is decreasing. These decreases in cycle time and overall reduction in open ended contracts are primarily due to 1) encouraging timely submission and response to change order actions by suppliers (penalties were instituted if responses were past the deadline) and 2) lowering authority levels to first-line managers.

6.2d Operational and financial results–Centerwide

Acquisition has shown significant increases in operational performance over the last 10 years with two periods of significant improvement in productivity (figure 6.15). In both cases, the increase in productivity can be attributed to improvements in technology and streamlining. The increase between FY90 and FY95 is due both to the automation of the Small Purchase process (see below) and streamlining of the process.

One aspect of small purchases (less than $25,000) that has shown improvement is the payment procedure. In July 1995, Goddard implemented a statistical sampling technique for the payment of all small purchase orders using recommendations from the U.S. Department of Treasury. This sampling technique enabled Goddard to save three work years of staff (~$150,000/year) and to meet its legislatively mandated prompt payment requirement. This mandate was strong motivation, since Goddard, like all federal organizations, is required to pay an interest penalty to the vendor if the payment deadline is not met.

A good example of improvement in internal operations is Goddard's SEWP program. Goddard has developed a new procurement system for some 15,000 workstations and peripherals and made it available across NASA and the rest of the federal government. It is a quick, simple method of procuring equipment from preselected vendors for preapproved pricing. This program as measured against objectives set by the federal government has been so successful that two Goddard employees received in 1995, one of the Federal Government's highest awards for enhancing its buying practices for procurements valued at $100M, the *Stetson Award*. Before SEWP in FY88, the average lead time for awards between $25K and $500K was 210 days. After implementation in FY93, average lead time dropped to 13 days. Figure 6.16 shows the number of actions in that category jumping by a factor of 10 while the lead time dropped by a factor of 16.

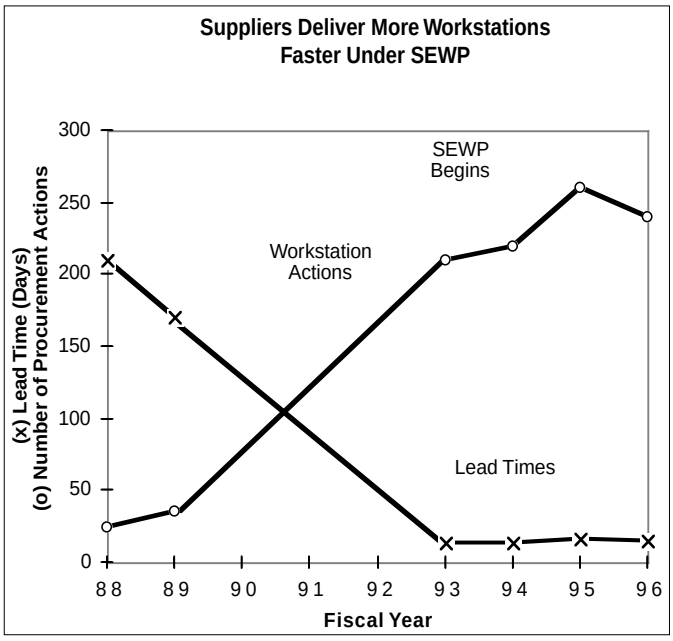


Figure 6.16

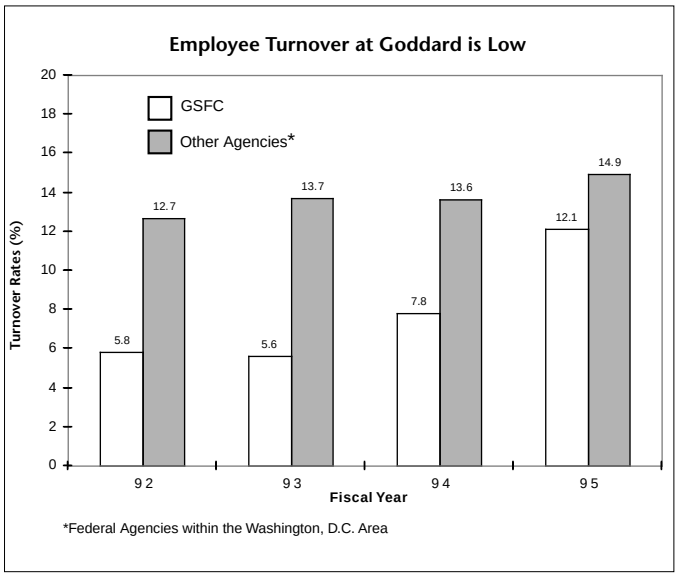


Figure 6.17

6.3 Human Resource Results

The extensive training and services provided by the Office of Human Resources at Goddard has been highly effective. The workforce is reasonably satisfied with the work environment when all factors are considered, despite the major downsizing that is occurring within NASA and the Federal Government as a whole. This satisfaction is reflected in the low turnover rates at Goddard when compared to other government agencies in the Washington, D.C. area (figure 6.17). The only major turnover in the last 5 years is due to government downsizing and associated "buy out" programs in 1994 and 1995 (317 buyout actions), not resignations.

Another measure of the effectiveness of the human resource services is the portion of the workforce that voluntarily takes courses through Goddard's training facility. The rate has grown steadily over the last 15 years and approached 100% of our workforce in FY95. Resources invested in training, and the number and sophistication of the courses taught, has increased as has the number of courses that an employee takes during the year (section 4.3a, figure 6.18).

Another measure of a favorable work environment is the amount of unused vacation time which civil servants donate to others who are on extended sick leave. Over the last 8 years, 72% of the workforce has donated 55,000 hours of vacation time. The average donor gives 22 hours of vacation time. These donation figures indicate a low absenteeism rate, since donations must come from unused leave.

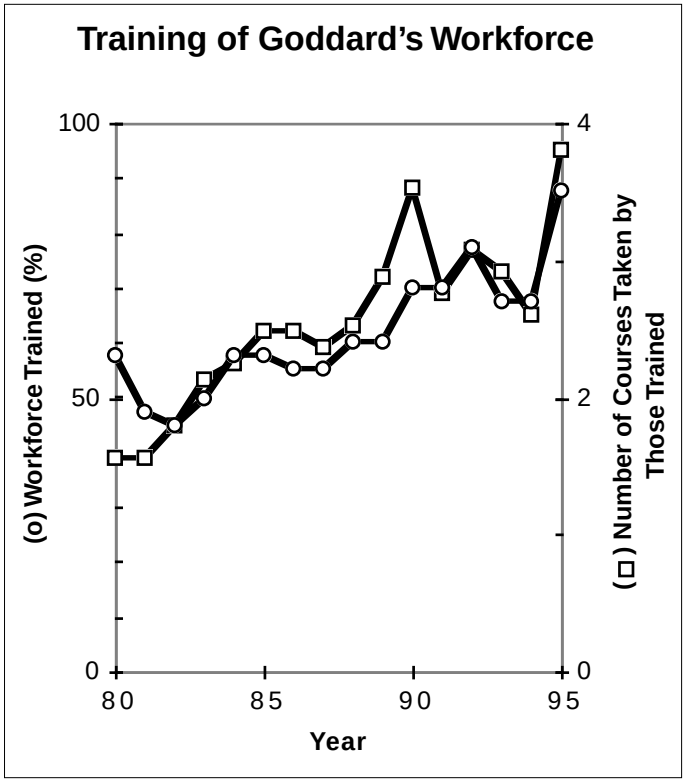


Figure 6.18

Goddard work environment is relatively safe in that there are a low number of cases of lost work hours due to injury. The number of cases has remained less than 1% of the total workforce since FY91. Average lost time is 2 days. Lost time is 0.30, below the NASA rate of 0.31.

Goddard has also been highly effective at diversifying its workforce. One of the mechanisms that it has used to increase diversity has been the Cooperative Education Program. This program which brings young, inexperienced workers into the workforce and gives them on-the-job training, has been highly effective. It has a high percentage of minority participants (about 50%) with about 80% of the participants converting to permanent civil servant positions. Lastly, Goddard has been effective at diversifying its workforce by improving the numbers of women and minorities throughout, and by increasing their effective promotion potential and increasing their percentage in senior positions (grades 14 through SES) (figure 6.19). See section 4.2a for more details.

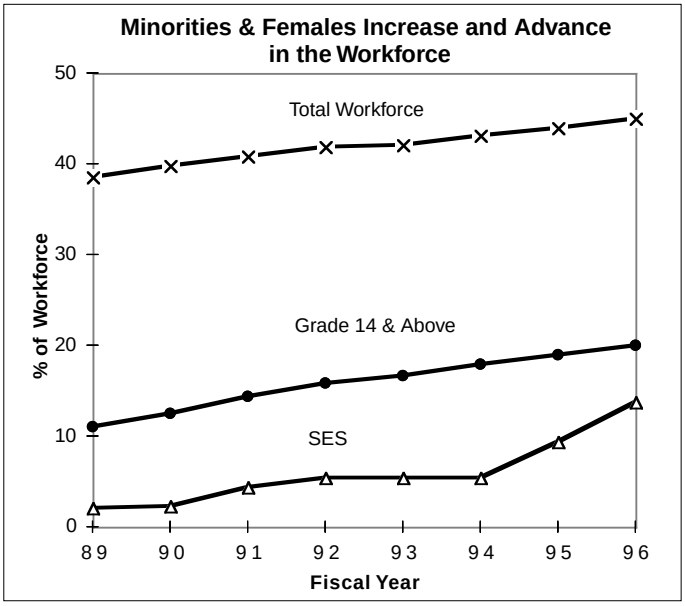


Figure 6.19

6.4 Key Measures of Supplier Performance

Suppliers to Goddard fall into several broad categories depending upon the type of contract and the type of products or services that they provide. Overall trends for "award fee" type contracts indicate the quality of the product or services that are provided to Goddard. Award fee contracts account for 67% of Goddard contract expenditures. The award fee rating system instructs evaluators to assign ratings of 100-91% for **excellent** work, 90-81% for **very good** work, 80-71% for **good** work, and 70-61% for **satisfactory** work. Hardware or software award fee contract performance hovers around 80%, while service contracts are near 90%.

In addition to overall award fee trends, experiences with individual contracts highlight new approaches which are being used to manage very large projects where most, if not all of the development work, is done "out of house" via contracts. Two such examples are the GOES I-M Project and the LANDSAT-7 Project.

The GOES supplier is tasked to build five GOES weather satellites, which Goddard delivers to our customer NOAA. In the past 5 years, Goddard launched GOES I and J (in 1994 and 1995, respectively,) and GOES-K will launch in 1997. NOAA requires that there always be two active GOES satellites (GOES-East and GOES-West) situated over the east and west coasts of the United States. This project in particular, prior to 1990/1991, had been unable to contain costs. The growth in the projected cost of the contract had grown steadily from 1987 through mid-1990 (figure 6.20).

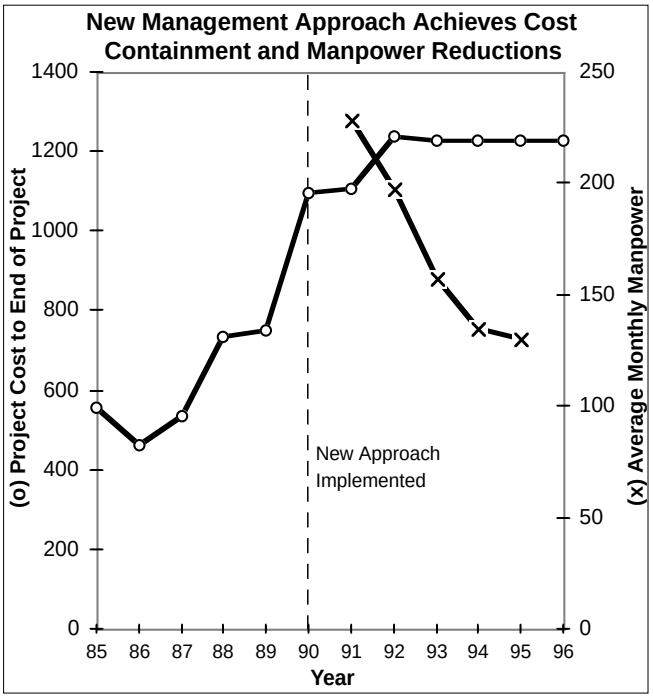


Figure 6.20

In late 1990 and 1991, a major change occurred in the management of this project with the assignment of a new project manager (1990) and a new instrument manager (1991). These managers brought with them a new approach to managing interactions with NASA's suppliers and customers. This change in management style resulted in the deceleration of the projected budget growth for this project in late 1990, and containment in late 1991. This containment was due to significant reductions in contractor manpower from 1991 to 1994, while meeting all customer requirements (figure 6.20).

The LANDSAT-7 Project has been able to achieve similar success using the same approach. They have reduced civil service manpower by 25% by eliminating all activities that duplicate contractor efforts. For example, Goddard now uses contractors for scheduling and configuration management. Problem analyses are not replicated by civil servants, as contractors are trusted to do their jobs. Goddard initiates process action teams of civil servants and contractors that bear responsibilities for work efforts instead of civil servants serving as watchers who have no product responsibilities. This restructuring and partnering has resulted in cost savings. LANDSAT-7 has cut the major spacecraft design, pre-environmental and consent to ship reviews in half without impacting quality of workmanship. Likewise, monthly reviews are significantly shorter and involve less travel and people. Instead of sending 10 - 12 people to a monthly review for 3 days, three Goddard representatives attend a review while others participate from Goddard via a video conference link, and the review is cut from 3 days to 3 hours. All these measures save money and free-up resources to address problems.

7.0 Customer Focus and Satisfaction

Goddard's role as a world-class scientific Center of Excellence gives it many unique responsibilities to its customers. The available indicators point to a high level of customer satisfaction.

7.1 Customer Knowledge

7.1a(1) Identifying our customers

NASA was created under the National Aeronautics and Space Act of 1958, which gives NASA Centers their general charter to pursue peaceful space activities for the benefit of all mankind. NASA Headquarters specifies the focus of each NASA Center, and is a key Goddard partner. Our partnership has led to a long, rich history of leadership in scientific achievements, especially in space and Earth science. The Center Director's initiatives to improve communication with our customers in other NASA Centers are described in section 1.1a. Our potential external customer community follows from our mission of scientific investigation and from the legislated mandates of outreach to industry, educational customers, and the general public.

Scientist Customers — both within Goddard and external. Our scientist customers are chiefly concerned with high-quality, leading-edge space missions that enable them to make significant scientific discoveries. Successful, scientifically productive missions result in customer satisfaction for this customer group.

Some scientists act solely as end-users of mission data, and it is their job to analyze the data, formulate knowledge from their analyses, and disseminate their products to their colleagues and the public. Other scientists, either Goddard employees or external team members, also participate in the mission activities as partners in the roles known as Principal Investigators on research projects. Project Scientists, who are responsible for science activity decision-making, are generally NASA employees, but they also represent the interests of many external customers who are part of a flight project. And there is a vital role for scientists who provide labor on missions while they are in graduate school obtaining advanced degrees. All of these scientists are Goddard customers in different senses, because they get from these activities the data, training, and support which they require for their careers.

In the spirit of scientific cooperation, scientists from inside Goddard and external scientist customers are welcome at Goddard and often collaborate to great benefit. Goddard's most direct external customers, the world's scientists, are typically a unique cadre of individuals with needs unique to their respective research environments. It is critical that

Goddard meet their individual needs as well as possible so that the world's space science, resulting from Goddard data, can be carried on. To this end, Goddard treats each science customer as an individual. Personal involvement and personal contact are key to learning and dealing with customer needs. Just as it is both ineffective and unnecessary for individuals who interact on a daily basis to learn the needs of their supervisor via survey, it would be inappropriate for us to deal with our primary customers through such a means. Therefore, we use personal interaction to gather feedback. Each science customer has constant personal interaction with Goddard project teams in both the developmental and operational phases of the project. Principal Scientists are, in fact, typically collocated with the project team to assure ongoing personal interaction throughout the life of the project. For example, the HST Project Principal Scientist's office is next door to the office of the Associate Director for the HST, though he officially works for another organization.

It is vital to note that in order to serve our scientist customers, the teams of internal and external customers that convey our services to them must also be given the same excellent level of service. These intermediate customers include the recipients of telemetry and flight data, who support space missions, many of whom are external to Goddard or on site but employed by other institutions. The Flight Projects and Mission Operations and Data Systems Directorates have responsibility to serve them.

Other Governmental Organizations. Other NASA Centers and federal organizations are our customers. Kennedy Space Center, for instance, relies heavily upon Goddard for tracking and data relay support. Goddard also provides NOAA with critical support — over $200 million per year — in maintaining the weather satellite fleet. Through WFF, we support the Navy, NOAA, and U.S. Coast Guard. Several foreign space agencies maintain partnerships in Goddard missions, e.g., the spacecraft in the International Solar-Terrestrial Physics (ISTP) program, provided by the European Space Agency.

Commercial Organizations. Our Office of Commercial Programs identifies and carries on a vigorous technology transfer program for businesses and other users of applied NASA technologies (e.g., medical institutions). At WFF, we support commercial launch service companies such as EER and Orbital Sciences Corporation.

General Public. Goddard has a long tradition of generous interactions with the general public, especially the Greenbelt community. (For example, the Challenger Center at the Howard Owens Science Center in nearby Greenbelt, which serves 90,000 K-12 school children per year, all over Prince George's county, has received key support in upgrading its computer facilities.)

The Public Affairs Offices and Visitor Centers at Goddard and WFF serve 100,000 U.S. citizens and foreign visitors per year who come to take tours or learn about key scientific discoveries and space program achievements.

The National Space Science Data Center (NSSDC) serves members of the public who request popular data products such as photos and CD-ROMs.

The Office of University Programs and many divisions of Goddard make strong outreach efforts to educational institutions. For example, the Minority University - SPace Interdisciplinary Network (MU-SPIN) program has reached out to historically black colleges and other minority universities with help in exploiting computer technology for the benefit of their faculties and students. Such outreach programs and the many summer student internship and mentoring programs that Goddard carries on each year introduce us to thousands of academic customers (see http://muspin.gsfc.nasa.gov/Home.html).

7.1a(2) Determining current and near-term customer requirements

We ask our customers their needs in many formalized or operational interactions equivalent to surveys and focus groups, and we collect and respond to customers' spontaneous requests in an ongoing dialogue process. More specific current/near-term needs for our customers are determined as follows:

Scientists. Potential scientist customers of Goddard missions propose candidate missions in response to NASA Announcements of Opportunity (AO). The proposal teams sometimes have been concentrated at Goddard, in other cases distributed among universities, other NASA Centers, or partnerships of any of these affilliations. This is an open process in which customers who know us provide specific information about their needs in the mission: what kind of instruments need to be built to measure physical parameters or acquire images of targets such as astronomical objects or features of the Earth; specifications of

instrument sensitivity needed to answer investigators' questions about those targets; and specifications for maintaining health and safety of the instruments in the harsh space environment. Such key customer needs are requested from proposing customers by Goddard and/or offered by customers who are veterans of space missions. A thorough dialogue, sensitive to every factor which adversely or beneficially effects the success of a space mission, is conducted with the scientist customers (see section 5).

The candidate missions are evaluated on the basis of scientific merits and feasibility considerations such as cost/benefit. Additional peer reviews outside NASA, such as independent committees of scientific organizations (e.g., the American Astronomical Society and the National Research Council), are solicited by NASA on mission proposal merits. These inputs from the most qualified independent experts ensure the undertaking of quality missions and the collection of objective information on the value of NASA and Goddard missions for the scientist customers. These independent reviewers are especially respected customers and their requirements are taken seriously. Successful proposals lead to mission definition.

Quality mission definitions, responsive to the scientists' requirements as mandated in the Strategic Plan, are assured by the Mission Development Cycle, described in the Overview and in section 5.1. As noted, customers specify mission requirements early in the cycle. There are numerous Goddard reviews that evaluate the requirements and reconcile any that are in mutual conflict. In later stages of the Mission Development cycle, any deviations from customer requirements are noted and resolved. The Science Working Group (SWG) established for the definition phase of a candidate mission is the principal team of interested scientists who provide critical input to the mission specifications.

In the preflight testing phase of a selected mission, and when a flight mission is under way, the intermediate customers who support mission science teams must be given what they need to establish high-reliability data transfer systems and data archive systems for the mission returns. Facilities are provided at Goddard or supported externally to guarantee that data flow to the customers quickly when the mission commences (e.g., Solar and Heliospheric Observatory (SOHO) Experiment Operations Facility; see below). Customer requirements for these supporting data systems—data flow capacities, storage requirements, data processing cycles, compatible hardware, etc.—are obtained in direct meetings with customers.

The foregoing explanation of how we know our customers' needs has emphasized how we ask what we need to know, but there is another key asset in this determination. Scientists within Goddard are also customers for the mission data products which are used in carrying on their own competitive careers. Therefore, they are internal forces for excellence in scientific achievement. Goddard has established "virtual" laboratories which act as centers of excellence in scientific discovery, and promote sharing data and results among the science disciplines that they serve, the broader scientific community, and the public. There are currently seven labs focused on fields that are key to Goddard's mission: High Energy Astrophysics, Astronomy and Solar Physics, Extraterrestrial Physics, Atmospheres, Terrestrial Physics, Hydrospheric Processes, and the Goddard Institute for Space Studies. Other organizations within Goddard, such as the Space Science Data Operations Office (SSDOO) and Space Data and Computing Division, also exist to serve scientist customers and include customer advocate specialists. The scientists in these labs and service organizations share the knowledge of what is currently most important to investigate in their own fields, they participate or exert influence to improve the quality of science missions undertaken, and they bring Goddard's institutional memory, experience, and wisdom to bear in the quest for discovery.

In addition, at WFF, launch customers are tenants, and an agreement called the Host-Tenant agreement is made, establishing what is expected of the parties in the course of each flight. See section 7.2a for more details of how WFF obtains customer requirements.

The NSSDC and the DAAC also publish newsletters, and make catalogs of most popular data sets available on WWW; orders from customers may be made via e-mail or postal mail. Goddard also promotes data on the WWW, in science magazines, college newspapers, workshops and fliers at science museums. Information from customers expressing their interest flows back, either to sources of archive data like NSSDC or directly to mission data centers.

The most important data needs of customers are determined by asking face-to-face at scientific workshops and conferences, by e-mail interactions, and by meeting with panels of science discipline experts such as the Space Physics Data System committee. Our customers tell us what data

are most important to them, and we provide them with access to browse and choose the elements that they need, to obtain copies of the data they choose, or to perform preliminary analytical actions using the WWW interface (e.g., http://nssdc.gsfc.nasa.gov/omniweb/ow.html). Accesses of data sets on-line by customers are logged, giving us automatic data about which of our data products are of greatest interest to them.

Other Governmental Organizations. Goddard holds regular meetings with other government customers such as NOAA in order to keep current information about their on-going and changing needs. Customer needs are documented in formal Memoranda of Understandings agreed by consensus with the customer, which specify responsibilities of Goddard and the customer. We invite cooperation where we see that it may benefit the customer; e.g., the 1995 launch of the Total Ozone Mapping Spectrometer (TOMS) instrument to measure ozone depletion is also potentially useful for the Federal Aviation Administration (FAA) in aircraft hazard avoidance and increasing engine performance efficiency via jet aircraft route selection, so the FAA was invited to join in TOMS data analysis. A TOMS was recently launched on a Japanese spacecraft, and a joint flight is also planned with Russia.

Commercial Organizations. An important part of Goddard's duties is to transfer the state-of-the-art technology we develop to industry. We do this through the Technology Transfer/Commercialization Office (TTCO) within the Office of Commercial Programs (OCP). OCP publicizes NASA technology in printed publications, conferences and workshops and schools, sets up Goddard-business partnerships, cost-sharing programs and licensing of technologies, makes grants for SBIR, and maintains a network of contacts with businesses and governments. Contacts are queried to measure results (e.g., commercial revenues generated).

The General Public. The public influences the services which Goddard provides by means of requests to the Public Affairs Office (PAO), which handles outside requests for science information. The many PAO functions mentioned in section 7.1a(1) are also opportunities to count interested audiences and track customer preferences. Information is collected on a continuous basis, and presented in monthly status reports to the Center Director. Recently, the PAO created a Goddard WWW site (http://pao.gsfc.nasa.gov), and with 75,000 accesses in its first month, the volume of e-mail feedback was far more than anticipated.

NSSDC interacts with data request customers via postal and e-mail, and compiles records of their needs.

Goddard learns about its customers while serving them in outreach programs such as MU-SPIN. Workshops have been held at Howard University, Fisk University, and Tougaloo College. The MU-SPIN On-line Network Resource Center has distributed thousands of reference documents, hundreds of Network Starter Kits, and served faculty and staff members from hundreds of universities and other institutions. There is vigorous participation in this program, and it has received numerous awards from outside institutions such as the National Science Foundation.

7.1a(3) Determining important product and service features

NASA Headquarters defines our key products and services through its overall program leadership. The important characteristics of our missions are strongly driven by consensus with our customers (e.g., the contents, functionality, configurations and staff levels in a flight project operations center). The suite of instruments aboard a spacecraft, for instance, is customer driven, within resource constraints and guidelines drawn by NASA Headquarters. These customer preferences are incorporated in response to the feedback obtained in preflight SWG meetings, and once flights are launched, in daily, weekly, and monthly planning meetings for science mission activities. Flight operations staff attend these meetings and act quickly upon requests for modifications from Project Scientists and Principal Investigator teams. The scientist customer's priorities are embraced by Goddard's project staff.

Archive data featured by NSSDC and other archive systems at Goddard are chosen on the basis of importance as assessed by in-house customer advocates, NASA Headquarters directives, interactions with scientists in the field, and in response to user feedback. E-mail requests for data from a particular spacecraft are monitored to assess emerging customer desires, and archive system personnel from NDADS, NSSDC's on-line distribution system, participate in scientific conferences where they ask customers what sets of data are desired by users.

The data that are most popular to the general public have spurred the creation by NSSDC and DAAC of CD-ROMs that collect the most important specific NASA data

in cheap, high-capacity packages (e.g., Voyager and Magellan images of the planets). Also the Goddard DAAC has surveyed its data users and responded to feedback asking for better user interface software, improved data formats and smaller file sizes, easier data ordering mechanisms, etc.

7.1a(4) Supporting data for determining customer needs

NASA Headquarters, a key customer, has expressed its satisfaction with our performance through investment of increased percentages of NASA's budget in Goddard activities (see section 7.4a).

Goddard does not have a Centerwide mechanism in place that counts all complaints in a collective database. Complaints are handled in systematized ways in the particular Goddard organizations because of the diverse activities of these organizations. Serious complaints are elevated to attention of Center management, as described in section 1.1a, and actions to correct problems are initiated.

Despite the absence of mission complaint/resolution statistics, however, Goddard continues to gain new science mission customers. This indicates that Goddard is regarded highly by its customers as a quality provider of mission services and scientific data products. A key indicator of customer satisfaction is customer retention and growth, both of which characterize Goddard's recent history. For example, Orbital Launch Services (OLS) has a roster of 32 launches to perform over the 1996-2000 time frame, a clear indication of satisfaction on the part of NASA Headquarters and other launch customers.

At WFF, key customers (Phillips Labs, NASA/Langley Research Center, Ballistic Missile Defense Organization, and NASA/Ames Research Center) return year-after-year to perform additional experiments.

Institutional organizations within Goddard, such as the SSDOO, are reviewed by visiting committees of independent scientist customers, who provide detailed performance evaluations of the data archiving and dissemination services provided by Goddard. SSDOO consistently receives positive reviews of performance and service to its customers. The numbers of customers grow continuously and dramatically each year, often with sudden surges corresponding to Goddard or NASA mission events or scientific events (e.g., the crash of Comet Shoemaker-Levy 9 into Jupiter).

The numbers of visitors to Goddard and other contacts with PAO, mentioned in section 7.1a(1), indicate demand for what we provide to the public.

7.1b Future customer requirements and expectations

NASA Headquarters and Goddard maintain close contacts to define Goddard's future directions and thrusts, on a weekly basis or with special meetings as appropriate. Goddard's Space Science Director participates on the board of directors of the Space Science Program Interchange Meetings.

Close integration with other customers is Goddard's approach to assessing their future needs. Mission review boards give customers opportunities to assess Goddard performance, and complaints are acted upon in follow-on missions (see also sections 2.3a-b). Analysis of the major factors affecting scientist customers is formalized in mission results reviews, which are often part of SWG meetings in planning for succeeding or follow-on missions.

An example is the improvement of spacecraft commanding and science operations at the new SOHO mission Experiment Operations Facility. SOHO is a platform for state-of-the-art solar astronomy. Many of the team scientists, including the Project Scientist, Art Poland, were investigators during the previous Solar Maximum Mission (SMM, 1980-1989). For SMM, the science operations and planning were carried out at a site on Goddard which was 0.5 km from the spacecraft command center. This separation limited the flexibility of responses to spacecraft problems and made it impractical to perform near-real time science operations. The lessons learned from SMM, the Japanese Yohkoh mission, and NASA's previous Skylab and Orbiting Solar Observatories, enabled the SOHO Science Operations Working Group to design a more responsive operations center for SOHO: an operations facility, colocated with spacecraft commanding facilities for fast responses, and a remote Experiment Analysis Facility for science planning, data archiving, and computations, linked by fast computer networks to the command facilities. These scientist customers—teams working with 12 instruments from as many nations—were brought into the mission planning, and many of them are detailed to Goddard by their home institutions to maximize the science productivity of SOHO. We have developed a science planning, communications, and data

archiving system which utilizes up-to-date WWW technology to make the SOHO operations a model for quick-response, collaborative, world-class space science (see http://umbra.nascom.nasa.gov/ using a WWW browser).

Scientist customers are the most demanding of leading-edge customers. For example, Instrument and Project Scientists present changing requirements for computer system and spacecraft behavior and performance as missions commence and progress. The project/science team meeting system is built on timely response to such requirements, which may be vital to spacecraft health and safety and therefore to mission success.

To anticipate rising customer expectations and competitive pressures, representatives of the MIDEX team made site visits in 1994 (called benchmarking visits) to small satellite developers. The organizations visited were Orbital Sciences Corp., Aero Astro, TRW (Chantilly, VA), CTA/DSI, NRL, Spectrum Astro, Lockheed, Loral, Phillips Lab (Edwards AFB), and Ball Aerospace.

Goddard visitors learned that the organizations found the pressure for cheaper, smaller, faster satellites was coming from DoD and commercial customers, was spurring revolutionary changes in engineering, and was driving fierce competition for a shrinking market. It is essential to use off-the-shelf components wherever possible, eliminate nonessential paperwork, keep the customer and spacecraft developer in close contact to align priorities, and co-locate teams for time efficiency. The benchmarking visits were eye-opening methods to make our in-house spacecraft engineering more competitive and show us who the best suppliers for small satellites would be.

Below is a list of key listening and learning strategies:

- Face-to-face regular meetings;
- Spacecraft incident reviews including science teams;
- Innovative R & D in collaboration with scientist customers;
- Public scientific conferences and workshops;
- Independent reviews by professional science experts;
- Close monitoring and exploitation of technological advances;
- Inreach and partnering technology activities with small/ large businesses;
- Postal and e-mail, and visits from scientists and general public; and
- Congressional and presidential interactions.

7.1c Evaluating and improving customer satisfaction

The processes previously described for mission management make the personnel of each flight project take ownership of their missions and responsibilities to the scientist customers. Project support personnel work frequently with the customers face-to-face to address action items. Operational chain of command is defined and adjusted frequently in response to science team complaints when delays are encountered in giving them satisfaction. Each lab and data distribution system has a process to capture lessons learned from one mission to the next. Currently, an automated lessons-learned system called RECALL, a case-based reasoning system, has been developed to improve the use of lessons learned across all Goddard missions. When fully deployed, it will fortify institutional memory of how best to serve mission customer needs.

The review processes mentioned in sections 2.3 and 5.1 also provide opportunities for improving Goddard's customer requirement determination processes.

Integrated Product Development Teams (IPDT) are a new way of doing business for Goddard. IPDTs are collaborations of engineering experts from competing industries and Goddard representatives brought together to match emerging technologies with future mission requirements. Goddard management has embraced IPDTs as a way of improving the process of assessing customer needs.

New business approaches like IPDTs arise because Goddard management includes critical review of our performance at staying in touch with customers (see section1.2b). Advisors to the Director such as the Special Assistant for Outreach are assigned to note inefficiencies and problems reported in the "Top Ten" reports, and formulate improved approaches or changes (section 1.1a). Improvements are institutionalized by putting improved procedures into performance appraisals of key employees and into contract performance specifications.

Goddard improves its customer assessment by introducing surveys of new customer segments which have not been sampled before. For example, a Process Action Team on Customer Value was recently established by the Logistics Management Division, a team comprised of logistics personnel from Greenbelt and WFF, contract employees, NASA Headquarters, and led by the Logistics branch head. The team is using an approach and statistical analysis method developed by the University of Maryland Center for Quality

and Productivity. To date, a series of interviews have been conducted with both internal and external customers, and a survey has been distributed to approximately 2500 people at Greenbelt and WFF. Survey results will be analyzed to identify customers' current and future support needs and, considering NASA's constrained resources and downsizing plans, make recommendations to improve, prioritize, and retool our services to reflect those needs.

Goddard has accepted the challenge of increasing educational outreach and appointed an Educational Programs Officer with a strong background in introducing science to public school curricula. The Office of University Programs (OUP) also was established to increase and strengthen Goddard's partnerships with higher education. These employees are charged with critiquing and proposing improvements to Goddard's educational activities. They propose new ways of doing business with educators, such as the Joint Venture (JOVE) program and the NASA Academy, in which teachers and students from institutions with no prior involvement with NASA come to Goddard to learn and work; JOVE teachers develop novel curriculum improvements and NASA Academy students support mission PI teams in actual research. OUP also uses WWW pages to announce its programs to potential customers.

7.2 Customer Relationship Management

7.2a Information and customer assistance

Scientists. NASA AOs give mission proposers the information they need to conceptualize their space missions (see section 7.1a(2)). Fast methods of distributing such information are used today such as WWW pages. During missions in progress, the SWG meetings and daily, weekly, and monthly meetings with flight project staff give the scientists extensive face-to-face access to critical contacts. They comment and interact in detail, and project staff members respond with the goal of resolving problems before the next meeting. Mission project staff operate flight control centers 24 hr/day and notify customers of problems arising, such as the need to take actions in order to preserve spacecraft or instrument health and safety.

Section 2.3a describes how operational and performance metrics are set, deployed and tracked generally. Standard support services are documented as part of mission development and these performance criteria are available to customers. Goddard procedures for problem reports are derived from the NASA Handbook, NHB 8070.5, which defines the requirements for significant problem reporting and trend analysis; these requirements specify that mission customer complaints are recorded and receive effective responses. The Office of Flight Assurance documents the proper procedures for reporting problems at Goddard, and there is now a WWW site at Goddard for problem reporting.

A customer's complaint is typically that data are not arriving from a spacecraft or instrument, there is a functional problem aboard the spacecraft, there is a delay or drop-out of data, or there is evidence of a dangerous condition aboard the spacecraft. The flight operations team addresses these complaints in real time with allocations of manpower and systems resources appropriate to the urgency of the complaint (level of threat to spacecraft and mission objectives being the key factors).

The Project Scientist and instrument PIs are often onsite at Goddard and personally involved in complaint resolutions, or they are kept informed if decisions are required, using telephone or e-mail. These people represent the interests of all of the scientist customers involved in a mission, so the process is very customer focused.

At WFF, a single project coordinator is assigned as point of contact for each customer. New customers are sent a booklet describing WFF and its capabilities, and technical documents such as an Experimenter's Guide are sent as appropriate. Customers can use the project coordinator to assure good two-way communications of their needs.

Science data that are provided to the broader scientific community are announced publicly as described in section 7.1a(2), and contact information is included, such as postal, e-mail and telephone contact persons. These same channels enable data requesters to comment and complain. The personnel responsible for our data archive facilities also attend scientific workshops and conferences, where they collect user feedback.

Other Government Organizations. One of the tasks of the Special Advisor for Outreach is conflict resolution concerning such partners as NOAA. She is a contact point and advisor to the Center Director, and suggests actions to resolve customer complaints at the interagency level. Issues are resolved as part of the "Top Ten" process. There are also periodic meetings with front-line teams who ne-

gotiate and carry out interagency project responsibilities, in which complaints may be reported.

International projects like ASTRO-E with the National Space Development Agency (NASDA) also are reviewed in the "Top Ten" meetings, and complaints reach the Center Director for responses, if they cannot be handled by "Directors of."

Commercial and Academic. Commercial and university customers obtain information and access via partnerships which have been established with them. The TTCO is available to answer questions and facilitate technology transfers. TTCO also distributes guides to potential customers such as the 1996 Engineering Reference Guide for Small Businesses, to increase awareness of the opportunities to partner with Goddard.

University customers benefit from partnerships that allow us to leverage our resources with the academic community and university scientists by exchanging ideas and people on a no-cost basis. This also enables students to work on projects which provide them training opportunities in satellite operations as well as science mission operations (e.g., transfer of the Extreme Ultraviolet Explorer operations to University of California–Berkeley).

General Public. The public and other users of the science data distributed by NSSDC are invited to comment on service quality when they receive requested data. Such comments have been received from approximately 5% of customers, and complaints were noted. Other Goddard data distribution systems such as NDADS provide e-mail contacts to customers for additional information or complaints.

PAO also collects complaint data through the channels described above (WWW, postal and e-mail).

7.2b Resolving customer complaints

As described in 2.3a, customer satisfaction performance is reviewed generally at the highest management level, where short-comings are addressed in the "Top Ten" process (section 1.1a) and later in periodic reviews.

Responsiveness to customer needs is principally the responsibility of the individual directorates at Goddard. Customer interactions are most often handled within Directorates. Science mission proposals, for example, would go to either science directorate and these directorates would work with the Engineering Directorate in construction of space hardware. Issues that arose at the directorate level which could not be resolved would be raised with the Management Council among the "Top Ten."

Actions taken by the directorates to resolve issues at the "Top Ten" level or within the directorate include immediate directives to employees or updating employees' performance appraisal criteria to add critical duties. Front-line employees then meet with the customers to ensure their satisfaction with the outcome.

Scientists. In the case of scientist customers, the most important complaints are those which occur with impact upon flight missions. Scientist customers who serve on active project staffs use the opportunities afforded by daily and weekly mission planning meetings to provide input to and influence mission activities. Goddard mission performance assessment opportunities exist for both on-site customers and off-site remote investigators, via e-mail and teleconference, as in the currently active SOHO mission. The project support staff meets with the customers and notes complaints, makes them action items, and carries them until resolution. Complaints are regarded with the greatest seriousness and are pursued responsively with mission and science success as the highest priority.

At WFF, after any failure, flight anomaly or incident, an investigation committee composed of experts throughout WFF is convened. The investigation report, prepared with comments from the customer, is widely circulated among NASA managers and recommendations are promptly implemented. Response to trouble calls is always within 4 hours, unless it is an emergency and response is immediate.

Other Government Organizations. Interagency complaints are handled at the level of the Center Director and his assistants who attend Management Council meetings and suggest definitive solutions.

General Public. The use of WWW interfaces and e-mail has stimulated fast responses from Goddard personnel to requests from the public, referred by PAO.

7.2c Following up on customer satisfaction

The mission AO and research program announcement processes described above are repeated annually or more often if appropriate. The surveys of customers for our data are refined and repeated. Public contacts such as workshops are attended and organized. Lessons learned are captured and summarized in review presentations for the Center Director and others. This topic is also discussed in section 5.1c.

At WFF, the principal formal means for customer feedback are the range debriefing and evaluation form requested at the completion of each project. Informal feedback is a continual process due to the close relationship between the customer and assigned coordinator. The customer is encouraged to question procedures and make suggestions as appropriate. WFF has also surveyed customers, and the results are summarized in section 7.4.

The TTCO follows up with commercialization contacts in order to measure the benefits to businesses which are members of partnerships and other programs. For example, contacts with potential commercial users of Goddard technologies made at workshops, trade shows, and through publications and the media led to 123 follow-through meetings, ongoing agreements, counseling, and negotiations.

7.2d Evaluating and improving customer relationships

"Top Ten" issues are reviewed by the Center Director and advisors such as his Special Assistant for Outreach, with sensitivity to inefficiencies or ineffective processes and to the potential for improvements from the customers' point of view. Process improvements arise as the Center Director and his assistants critique inefficiencies, with the view that "any process can be streamlined," and they propose modifications. Section 5.2b also discusses this topic.

At WFF, the Policy and External Relations Office was formed to improve the responsiveness to customer concerns.

7.3 Customer Satisfaction Determination

7.3a Determining customer satisfaction

Customer satisfaction is determined in various ways at Goddard, depending upon the product.

NASA Headquarters. Satisfaction on the part of the NASA Headquarters internal customer is communicated directly by the customer in reviews and directives. In the case of science missions, HQ reviewers specifically state their opinions about results in mission reviews and press conferences.

Scientists. Science customers provide feedback to mission operations personnel in daily and weekly meetings while missions are in progress. The Project Scientist for each mission provides his/her level of approval, and PIs speak for their respective instrument teams.

Science data customers provide feedback to Goddard mission representatives at science workshops, where presentations describing and promoting new science missions are made—both before flight during mission definition and during mission progress.

Operational units such as the Mission Operations and Systems Development Division (MO&SDD) are critical customer interfaces. MO&SDD captures all spacecraft telemetry, troubleshoots transmission problems, and ships the data to mission customers.

MO&SDD recently surveyed 142 customers — data customers from a variety of flight projects — to assess their views of how well this vital service was being provided, using a telephone interview consisting of 11 questions. These included broad inquiries into satisfaction with quality of data received, quantity of data received, timeliness, physical condition of media received, and details and suggestions for improvements in service. (For a summary of results, see section 7.4a.)

An equally vital operational unit is the OLS Project, manager of Goddard's highly reliable Expendable Launch Vehicles (ELV). In 1995, OLS surveyed its payload project customers to assess how well OLS met their needs, identify strengths and areas where improvement was possible. Letters of solicitation and forms were sent to key people on all customer projects during the first half of 1995, and these were followed up with phone calls. All responses were entered into a database archived in the OLS Work Files. Numeric scores were given on a scale of 0 to 5, with 0 being no comment and 5 being excellent, in 23 specific areas of launch services. The service areas surveyed fall into three general categories: service quality, mission support from OLS Project, and performance of service contractor.

Results of the OLS survey are discussed in section 7.4b.

WFF asks each range user to fill out an evaluation of seven service categories: Project Planning, Safety, Vehicle Preparation and Launch, Instrumentation, Airport, Range Control and Operations, and Data Reduction and Distribution. Comments were also invited. A "Dear Colleague" letter was also sent to scientists who have used sub-orbital launch services under NASA's Sounding Rocket Program. The results are presented in section 7.4.

NSSDC and other data distributors assess e-mail and postal interactions with customers on a continuous basis. These customer interactions are reported monthly at NSSDC, and complaints evaluated, such as comments about price structure for CD-ROMs.

Other Government Organizations. Customers such as NOAA are asked their opinions of Goddard performance in frequent interagency meetings. Goddard houses six NOAA people onsite in building 6. Launch service processes also keep Goddard personnel in touch with the day-to-day customer needs.

General Public. The general public provides feedback through fan mail to the PAO, which receives and evaluates it. Much of the system for doing this has been described above. The TTCO surveys our contacts and records metrics of their satisfaction, as presented in section 7.4. These metrics include numbers of jobs created and revenues generated, as well as patent licenses granted.

7.3b Comparing customer satisfaction with our competitors

We currently do not measure this; it's an area where we recognize that we need to improve. One metric that we have on this is how our launch service success (and consequent customer satisfaction) compares with some competing launch services; this metric reflects favorably on Goddard. (See section 6.1c.)

7.3c Evaluating and improving measures for determining customer satisfaction

Surveys of customers are taken, critiqued for inadequate returns of customer impressions, and improved. NSSDC, for example, is about to perform an improved user satisfaction survey.

New technology such as e-mail and WWW pages have been added to the survey and customer response collection methods.

Since Mr. Rothenberg was appointed Center Director in 1995, he has elevated sensitivity to customer dissatisfaction and urged new efforts at outreach. He continually suggests new ways for "Directors of" to sense the customer environment and respond. The "Directors of" in turn stimulate improvements in customer surveying and outreach.

7.4 Customer Satisfaction Results

A wide variety of indicators show strong customer satisfaction with Goddard performance.

7.4a Customer satisfaction

NASA Headquarters. One indicator of high confidence in Goddard is the assignment of the chief roles in Mission to Planet Earth and in the Space Science Enterprise to Goddard (these are key elements in the 1995 NASA Strategic Plan).

Another indicator of NASA Headquarters' satisfaction with Goddard performance is Goddard's Center budget as a fraction of NASA's total budget. In FY90–96, the fractions were 13.9%, 14.3%, 13.5%, 15.2%, 16.4%, 18.5%, and 16.7%. The trend from 1990 through 1995 reflected NASA Headquarters' willingness to invest a growing percentage of agency resources in Goddard programs. Even with the NASA budget reduction of 1996, Goddard percentage was well above 1990's level. Goddard is also managing a larger number of missions per dollar, so this is a valid indicator of increased quality.

NASA Headquarters recently conducted a review of the sounding rocket and suborbital balloon research program; this review validated the need to continue the suborbital program, and to continue the program at WFF.

In the key performance category of science missions, Goddard's OLS received a commendation on Mar. 7, 1996, from W. T. Huntress, Jr., AA for Space Science, NASA Headquarters: "On behalf of the scientific community I would like to commend Goddard's OLS team for outstanding launch support provided over the last 4 months. During this period, OLS was responsible for the acquisition and management of the successful launch of four critical scientific payloads aboard Delta ELVs... The professionalism and dedicaton of your ELV team, who worked through furloughs, holidays, and a myriad of technical and weather constraints, enabled XTE, NEAR, and POLAR to be deployed into excellent orbits. ...Goddard OLS team's ability to perform under these challenging circumstances is a credit to Goddard and the Agency."

Scientists. The National Research Council (NRC) in its 1991 evaluation The Decade of Discovery in Astronomy and Astrophysics commended NASA for its support of the

analysis of the data from Goddard's Infrared Astronomical Satellite (IRAS), calling the IRAS Guest Investigator program a model for the active support of Explorer missions. The NRC committee of authors also urged NASA to support Goddard's Cosmic Background Explorer data analysis in the same way, and that was done through operation of a sophisticated facility at Goddard. Goddard responded vigorously to the voice of the scientist customer community through their representatives on the NRC Panel.

The scientists of the world are our most discriminating external customers. Their interest in our peer-reviewed scientific products is reflected in figure 6.3 which shows the trend in citations of papers by Goddard scientists over the past six years. Citations are the metric of important scientific work in the qualified opinions of our scientists' peers, and Goddard's record reflects strong respect and satisfaction by peers.

OLS has an unbeatable launch record of ELVs from 1988 (the inception of the Commercial Space Launch Act) to the present of 100% success, a reliable indicator of customer satisfaction. (See section 6.1c for comparisons with U.S.Air Force and commercial launchers.) Another key indicator of customer satisfaction is customer retention and growth. OLS has a roster of 32 launches to perform over the 1996-2000 time frame, a clear indication of satisfaction on the part of NASA Headquarters and other launch customers.

OLS surveyed its customers in 1995, as mentioned in section 7.3a. The results averaged over OLS launch services (black bar) and ratings of four individual services (Medium-ELVs, Small-ELVs, ULTRA-LITE, and NOAA) are shown in figure 7.1. The four groups of bars correspond to the four rating categories "Service Quality," "Mission Project Support," "Contractor Support," and "Overall." It is noteworthy that average ratings are above or near 4 (Good) in every rating category. Lower ratings received extra attention and evaluation and led to corrective actions to improve service (e.g., personnel changes that corrected the low NOAA Mission Support rating). It should be noted that NOAA was highly satisfied at the outcome of their recent launch, which occurred after the survey (see below).

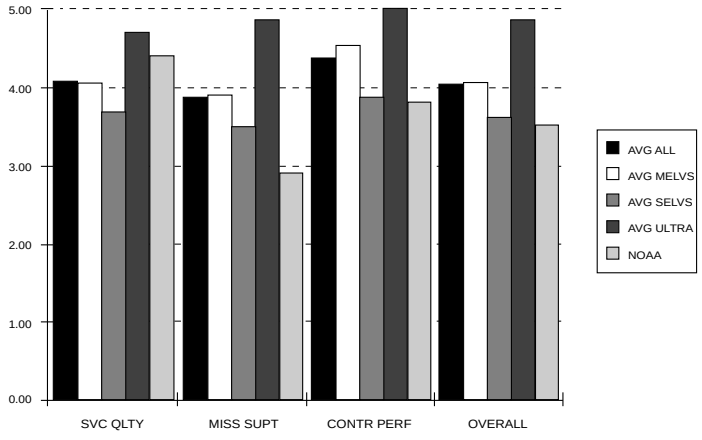


Figure 7.1 1995 OLS Customer Survey

Table 7.1 NASA Sounding Rocket Program

FY	Total Missions	Launch Vehicle Failures	Payload Failures	Mission Objective Failures
1991	25	1	2	3
1992	32	0	1	1
1993	20	2	4	6
1994	33	1	7	8
1995	30	0	5	5
1996*	22	0	3	4

** 5 more launches are scheduled this FY*

WFF also has an impressive sounding rocket-launch record. (See section 6.1c and Table 7.1.) The customer survey results mentioned in section 7.3 are: for 1995 82% rated Support "Outstanding" and the remaining 18% "Excellent;" no one rated any category "Satisfactory," "Poor," or "Unacceptable."

Respondents to the "Dear Colleague" letter from WFF totalled 61 individuals in various science disciplines. All but one letter were extremely positive. All letters praised the "low cost" of the sounding rocket launch opportunity, many called it a model for "better, faster, cheaper," and said that there should be more sounding rockets, not fewer. Comments about WFF and its management were all very positive, and the centralized "corporate memory" was cited as very important. The majority of letters thanked the WFF evaluation committee for taking into account the views of the user community.

As mentioned in section 6.2b, the rate of TDRS data delivery to customers reflects increased demand and indicates satisfaction by data users.

As mentioned in section 7.3a, the customers of the MO&SDD were surveyed to determine satisfaction levels with telemetry data that were shipped to them. These surveys

were performed in Jan. 1992, Feb. 1993, and Sept. 1994. High levels of satisfaction were found, e.g., from Feb. 1993 to Sept. 1994, the percent of customers who said "yes" (that they were satisfied with data quality) rather than "no" (unsatisfied) rose from 95.7% to 97.2%. Satisfaction with data quantity increased from 97.1% to 97.8%. Satisfaction with timeliness fell slightly from 95.7% to 94.3%, which was still a high value, considering that the data load had increased significantly and extra effort was being expended to keep the capture rate high despite the increased load.

MO&SDD implemented close monitoring of the percent on-time figures for data in response to these surveys, and now provides 100% of data on-time to most of the projects it serves. This is excellent performance, especially in view of the fact that the data rate quadrupled at the beginning of 1996 when several new missions began.

NSSDC has achieved a dramatic improvement in satisfaction of customers. In the early 1990s, comments from customers were 5% unfavorable, for various reasons, chiefly delayed or incorrect delivery of requested data, and for dissatisfaction with price structures. A CMI program of process streamlining was undertaken by the support contractor, Hughes STX, price structures were revised, and a dramatic improvement occurred in the past two years. Currently, 1% or fewer customer comments are negative, and this mainly reflects some remaining dissatisfaction with prices.

NDADS offers NSSDC data from key space missions to requesters via automated network delivery of thousands of data files per month. Strong growth in use of these systems in recent years is illustrated in figure 6.6, and demonstrates intense customer enthusiasm for the data products. The average request rate of files indicates usage by science data customers. One of the noteworthy successes is the International Ultraviolet Explorer (IUE) archive use rate (figure 7.2), which shows an especially high-demand service which Goddard provides to astronomers.

The Goddard DAAC has experienced a tremendous growth of demand for its Earth science products, as mentioned in section 6.2b, with a client base growing from 1,500 to 30,000 in a year. The DAAC produced a popular CD-ROM including a wide range of data, models and software, and surveyed the recipients for satisfaction. Responses indicate that the CD has enabled research that would not have been performed in its absence, that more extensive investigations are being done because the CD was available, that it has cut individual PI manpower costs by anywhere from 1 month to 1 year, and that there was an unanticipated benefit: the CD set is used in both undergraduate and graduate Earth science instruction.

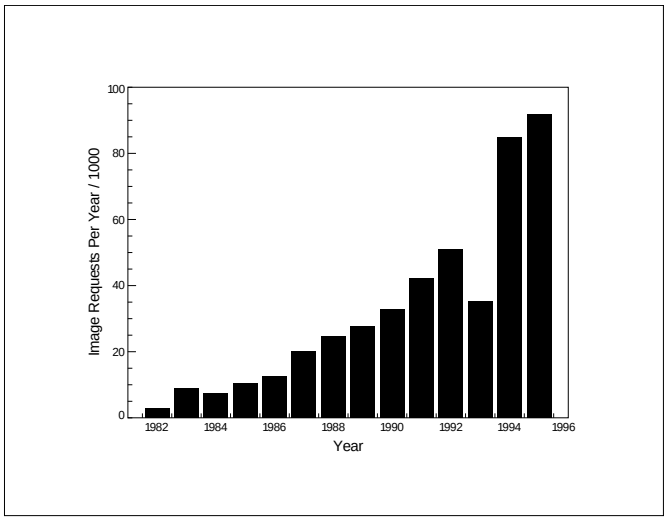


Figure 7.2 IUE Archive Usage (1982–1995)

The trends of surging demand are also found in Goddard DAAC products (figure 6.6).

Other Government Organizations. Another measure of the satisfaction of external Goddard customers is the amount of reimbursable funds which Goddard receives in return for services to other federal agencies and organizations. From 1990 to the present, reimbursable funds to Goddard grew from $250M per year to $300M. These funds reflect a large and growing reliance upon Goddard by other agencies and organizations.

KSC relies upon Goddard for tracking and data transmission support to Shuttle missions. After each mission, the astronaut team travels to Goddard to thank the support staff here for a consistently excellent level of support.

NOAA has expressed great satisfaction with the continual improvements made to the NOAA series of spacecraft, built and launched under Goddard management. As specified by NOAA originally, the ten spacecraft of the current series would have provided 128 months of weather science data. The actual performance of the ten spacecraft yielded 208 months of weather science data, because of continual improvements that led to extended operational lifetimes. This resulted in savings to NOAA of $98M to date, comparing the planned cost of the system to the actual cost, from 1978 to 1996. In its future budget submissions, starting with FY 98, NOAA is now assuming an operational spacecraft life

based on the actual and predicted performance of the spacecraft, substantially reducing their funding requirements for this system for future years.

Commercial Customers. Comments elicited from WFF range users in the evaluations mentioned earlier reflect strong satisfaction. Gerald Robinson, Space and Missile Systems Center, Mission Director for Airborne Intercept Experiment: "Every aspect of the Wallops Range Services was outstanding." He also complimented the fast planning and execution. Artie Jessup, OPS Engineer: "Excellent example of cooperation between Langley Research Center, WFF, Boeing Co., and avionics vendors. EXCELLENT JOB!"

The TTCO has surveyed our commercialization partners to learn the benefits that they have received from our relationship. Twenty partnerships were in effect from Jan. 1995 to May 1996, resulting in 138 jobs and $5,000,000 in revenues to these businesses.

Beyond the numbers of jobs and money, however, more far-reaching results come from technology transfer. For example, Goddard's microcircuitry technology was used in a cardiac defibrillator and commercialized by Cardiac Pacemakers, Inc., of Pittsburgh. Since 1991, this device has been implanted in more than 100,000 patients, greatly reducing their risks of fatal heart attacks.

General Public. In 1992 at WFF the Colorado Student Ozone Atmospheric Rocket was successfully launched. It was the first student-managed, student-built payload flown on a NASA Sounding Rocket, in a program that was developed to demonstrate the value of sounding rocket flights in education. The flight was normal, and when the payload was retrieved safely, the customers expressed their satisfaction: "It was amazing, beyond words."

The users of our PAO services and other WWW distribution and feedback channels express strong approval with their comments and skyrocketing demand for images and other information. Typical e-mail response to the PAO WWW page: "Thank you! Thank you! You cannot possibly imagine what it means to the 'little guys' to have access to such beautiful and awesome images as those generated by the HST." Another response: "I never got a chance to tell all of you at NASA what a great job you are doing!!! Keep up the good work!! You are our future."

The WWW distribution of data and images enabled NSSDC to support the massive user demand for images of the Comet Shoemaker-Levy 9 collision with Jupiter in 1994 — an event of such news-worthiness and educational fascination that NASA computers at four Centers were taxed to their limits in satisfying the demand for data files via WWW (see http://nssdc.gsfc.nasa.gov/sl9/comet_images.html with a WWW browser). From July 18 to 29, 1994, during the bombardment of Jupiter by comet fragments, nearly 400,000 WWW accesses were logged by NSSDC computers; nearly all of these accesses consisted of the requester receiving images and captions of Jupiter and the comet. The WWW automatically fulfills requests but does not automatically record satisfaction on the part of the receiver; however, users can see the name and e-mail address of a contact person, and there was overwhelming satisfaction expressed in NSSDC feedback for providing a dramatic new service.

Finally, among our satisfied customers in the general public, we include the countless people worldwide who have been rescued from life-threatening disasters or storms, using satellite technology programs with Goddard participation. A growing application of satellite technology that directly serves the general public in life-and-death situations is the Search and Rescue project, operated by the Search and Rescue Satellite Aided Tracking (SARSAT) Division of NOAA/NESDIS with Goddard participation. The SARSAT instrument, a distress beacon receiver which is carried on NOAA Television Infrared Observing Spacecraft satellites, was conceptualized and originally developed at Goddard. The number of persons rescued annually has grown from 250 in 1990 to 1000 people in 1994.

Another similar technology, the Automatic Picture Transmission (APT) service, has been provided by Goddard to more than 125 countries in the world which are frequent targets of violent storms. These systems provide warnings of sudden violent storms in places like Bangladesh, where hundreds of thousands of lives were lost annually because reliable warnings were not possible before APT. In 1992, members of the Prime Minister's staff from Bangladesh visited Charles Vermillion at Goddard, the inventor and travelling installer of these systems, to officially thank NASA's Goddard for the benefits of the cyclone warning system to their nation.

7.4b Comparing customer satisfaction indicators with our competitors

Despite significant competition from other NASA centers and other nations' space agencies for launch opportunities, Goddard has a history of retaining science customers, internal and external, such as scientists from the university community who have repeatedly flown better instrumentation on Goddard spacecraft. These scientists are not simply selected by NASA; they must propose their improved instruments at considerable cost and effort. These new and retained science customers have demonstrated their confidence in Goddard, and attained historic scientific breakthroughs, such as the measurement of the cosmic background spectrum with the Cosmic Background Explorer.

Goddard's OLS can also contrast its perfect success record (section 6.1c) and consequent customer satisfaction to other up-and-coming launchers such as the recent Ariane-5 and Pegasus. WFF also has a very competitive string of 74 successive successful suborbital missions, 22 this year.

In fact, the capabilities of flexibility, rapid response, and low cost despite higher risk in the Sounding Rocket program at WFF is not duplicated anywhere in the world. Many experiments could not be conducted at KSC, for example, because of higher liability insurance costs, scheduling conflicts, and rather rigid procedures on range operations. Consequently, many customers say they could not conduct sounding rocket experiments if WFF did not exist.

One indirect but definitive metric of Goddard's relative success in commercializing technology developments and the level of satisfaction on the part of the beneficiaries is shown in figure 7.3. The Office of Patent Counsel reports that royalty income received for Goddard technologies was nearly 50 % of the royalty income received for all NASA technologies during the 1995 FY. Our customers are using the new technologies that Goddard develops to strengthen industry.

In view of all of these data and indicators of the satisfaction of Goddard's many customers worldwide, with the world-class performance of Goddard in serving its customers with scientific and technological advancements and information services, Goddard is pleased to apply for the President's Quality Award.

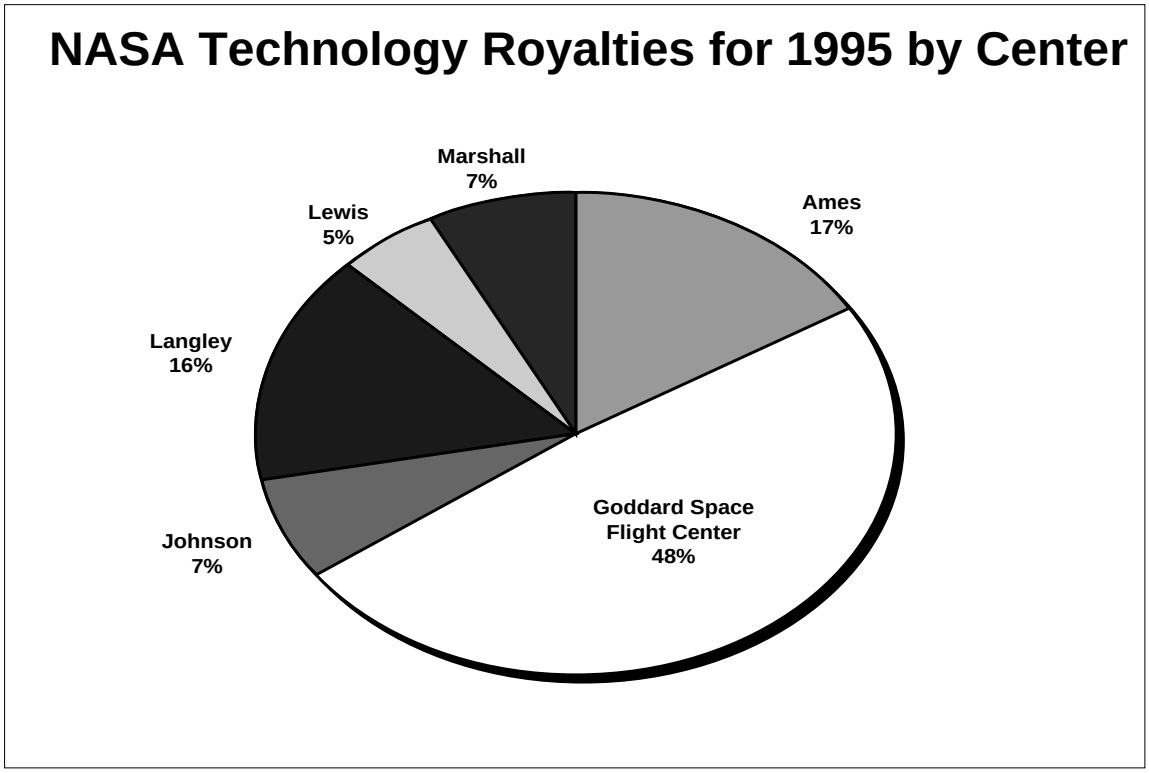


Figure 7.3

ACRONYM	DEFINITION
AA	Associate Administrators
ACE	Advanced Composition Explorer
ADR	Alternative Dispute Resolution
AO	Announcements of Opportunity
APT	Automatic Picture Transmission
CD	Compact-Disk
CD-ROM	Compact Disk–Read Only Memory
CI	Continuous Improvement
CIO	Chief Information Officer
CPI	Continuous Process Improvement
CPP	Competitive Placement Plan
CSC	Computer Sciences Corporation
DAAC	Distributed Active Archive Center
DDF	Director's Discretionary Fund
DoD	Department of Defense
DRP	Design Review Program
EEO	Equal Employment Opportunity
ELV	Expendable Launch Vehicle
EOS	Earth Observing System
EUVE	Extreme Ultraviolet Explorer
FAA	Federal Aviation Administration
FAST	Fast Auroral Snapshot Explorer
FDO	Fee Determination Officials
FMSA	Functional Management Self Assessment
FUSE	Far Ultraviolet Spectroscopic Explorer
FWS	Flexible Work Schedule
GCA	Goddard Contractor Association
GDS	Ground Data Systems
GERT	Goddard Emergency Response Team
GESTA	Goddard Engineering, Scientists, Technicians Association
GEWA	Goddard Employee's Welfare Association
GISS	Goddard Institute for Space Studies
GLES	Goddard Leadership Education Series
GLOBE	Global Learning and Observations to Benefit the Environment
GLP	Goddard Leadership Program
GMI	Goddard Management Instructions
GOES	Geostationary Operational Environment Satellite
GPS	Global Positioning System
HST	Hubble Space Telescope
IDP	Individual Development Planning
IFMS	Integrated Financial Management System
ILS	Integrated Logistics Support
IMAGE	Imager for Magnetopause-to-Aurora Global Exploration

ACRONYM	DEFINITION
IPA	Intergovernmental Personnel Act
IPC	Institutional Planning Committee
IPDT	Integrated Product Development Team
IRAS	Infrared Astronomical Satellite
IRM	Information Resources Management
IROC	Information Resources Oversight Committee
ISI	Institute for Scientific Information
ISTP	International Solar-Terrestrial Physics
IT	Information Technology
IUE	International Ultraviolet Explorer
JOVE	Joint Venture
JPL	Jet Propulsion Laboratory
KSC	Kennedy Space Center
LaRC	Langley Research Center
MAP	Microwave Anisotropy Probe
MELV	Medium Class Expendable Launch Vehicle
METS	Mission Enhancements and Team Building Seminar
MIDEX	Mid-sized Explorer
MO&DSD	Mission Operations and Data Systems Directorate
MO&SDD	Mission Operations and Systems Development Division
MOD	Management Operations Directorate
MSR	Monthly Status Review
MTPE	Mission to Planet Earth
MU-SPIN	Minority University–Space Interdisciplinary Network
NASDA	National Space Development Agency
NASA	National Aeronautics and Space Administration
NBC	New Business Committee
NIT	New Initiatives Team
NMI	NASA Management Instructions
NOAA	National Oceanic Atmospheric Administration
NRC	National Research Council
NSSDC	National Space Science Data Center
OCP	Office of Commercial Programs
OD	Organizational Development
OHR	Office of Human Resources
OLS	Orbital Launch Services
OUP	Office of University Programs
PAO	Public Affairs Office
PBC	Performance Based Contracts
PEB	Performance Evaluation Boards
PI	Principal Investigator
PIP	Professional Intern Program
PMDE	Project Management Development Emprise
POES	Polar Operational Environmental Satellites

ACRONYM	DEFINITION
QSR	Quarterly Status Review
RAMIS	Random Access Management Information System
RAO	Resources Analysis Office
RCM	Reliability Centered Maintenance
RENAISSANCE	Reusable Network Architecture for Interoperable Space Science, Analysis, Navigation, and Control Environments
RFO	Refocusing Opportunities
RFP	Request for Proposals
S&E	Scientists and Engineers
SAMPEX	Solar, Anomalous, and Magnetospheric Particle Explorer
SARSAT	Search and Rescue Satellite Aided Tracking
SBIR	Small Business Innovative Research
SDCD	Space Data and Computing Division
SEB	Source Evaluation Boards
SEL	Software Engineering Laboratory
SELV	Small Expendable Launch Vehicle
SEWP	Scientific and Engineering Workstation Procurement
SMEX	Small Explorer
SMM	Solar Maximum Mission
SOHO	Solar and Heliospheric Observatory
SPS	Small Purchase System
SSDOO	Space Science Data Operations Office
SWG	Science Working Group
TDRS	Tracking and Data Relay Satellite
TDRSS	Tracking and Data Relay Satellite System
TIROS	Television Infrared Observing Spacecraft
TOMS	Total Ozone Mapping Spectrometer
TQM	Total Quality Management
TRACE	Transition Region and Coronal Explorer
TTCO	Technology Transfer/Commercialization Office
WEMA	Wallops Employee's Welfare Association
WFF	Wallops Flight Facility
WIRE	Wide-field Infrared Explorer
WWW	World Wide Web
XTE	X-ray Timing Explorer